Table of Contents.

ENGINEERING SOCIETIES BUILDING. ..... FRONTIS-PIECE.

SHIRT, COLLAR AND CUFF FACTORIES AND LAUNDRIES, *Edward H. Keith.* 5

DENATURED ALCOHOL, PART II, *J. Albert Robinson.* 20

THE CEMENT INDUSTRY OF THE UNITED STATES, *F. C. MacKnight.* 43

EDITORIALS. 48

SECRETARY'S REPORT, BRANCH OFFICES, AND UNDERWRITERS' LABORATORIES. 53

CLOTHING FACTORIES—FIRE RECORD. 57

FLOUR MILLS AND GRAIN ELEVATORS—FIRE RECORD. 69

SPRINKLER FIRES. 72

MISCELLANEOUS FIRES. 80

NOTES AND TABLES. 85

AUTOGENOUS WELDING BY THE "EPURITE PROCESS."

RECLAIMING SPENT PYRITES.

"BURNITOL" CUSPIDOR.

ANTINONNIN.

OPEN SPRINKLER DISCHARGE TESTS.

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THE ENGINEERING SOCIETIES BUILDING.
29 West 39th Street.
Branch office N. F. P. A. in this building.

Shirt, Collar and Cuff Factories and Laundries.

PROCESSES AND HAZARDS.

A shirt is a garment, formerly the chief undergarment of both sexes. Now the name is given to a garment worn only by men and is usually made of cotton with bosom, wristbands, and collar prepared with starch for stiffening; the collar or cuff being usually separate and adjustable.

A collar is the part of the garment which is worn round the neck and forms the upper border—the neck band of a coat, cloak, dress or shirt, etc.—either standing up round the neck or folded over upon the garment; also a separate article of attire worn around the neck. Now, the name "collar" is particularly applied to the band (often separate) of linen, muslin, lace, etc., which in various shapes is worn as an ornament or finish to the upper part of the ordinary dress of men and women.

Shirts and collars have been worn, in some form, by civilized people since the beginning, but the modern shirt and detachable collar dates from about 1832 A. D.

> "The gentility of most men is contained in their shirt collars; remove it, supply its place with a ragged, woolen muffler or kerchief of ancient date and the effect is marvellous and sad."

The cuff is a distinct terminal part of the sleeve at the wrist, intended for embellishment. It was made originally by turning back the sleeve itself and was a true cuff. In recent times it is a separate or attached band of linen or other material worn about the wrist and appearing below the end of the sleeve. As worn by men, it is fastened to the wristband of the shirt, or it may and often does constitute a part of the sleeve itself.

*"According to the United States census of 1900, the manufacture of collars and cuffs is the most extremely localized industry in this country, 89½% of the cuffs and collars are made in Troy, N. Y., and 99.4% are made in New York State, 68.7% of the population of Troy being employed in this industry alone. But the shirt manufacturers are scattered all over the United States. The collar of trade, the detachable collar, is distinctly a Troy invention and had its conception seventy-five years ago in the mind of the wife of a blacksmith, who is stated to have made for sale the first detachable collar. Prior to that time shirts were made with collars attached. In 1835, Independence Starks, a Troy collar manufacturer, started the first "Troy Laundry" in connection with his factory. In 1852 the sewing-machine was first used in connection with collars and cuffs and in

*For the following statistics the writer is indebted to an article in the Encyclopaedia Americana by Mr. E. O. House, Vice-President of the United Shirt & Collar Co., of Troy.

1875 the first buttonhole machine was introduced. Without this invention, the manufacture of collars and cuffs could not have reached its present proportions. The manufacture of collars and cuffs is attended with great detail, twenty-five distinct operations are necessary in the manufacture of a single collar."

This paper will consider the shirt, collar and cuff factories and laundries as found in and around Troy, N. Y., which is the center of the industry in this country.

The factories vary from small plants where cutting and sewing only are done, mainly in tenant buildings, to full process plants which do their own laundering; many large concerns also do their own paper box making, packing case making, and printing, thus adding the hazards of these processes to the strictly, Shirt, Collar and Cuff hazards.

It is not the province of this paper, however, to take up the subsidiary hazards of this class in detail, as they probably will be treated separately in future papers.

The buildings are mainly of brick and vary from joist to mill construction, usually from three to five stories in height, mainly in two or more sections, with floor areas of 5,000 to 9,000 square feet in each section.

Stock. The stock consists of cotton, linen and flannel cloth in cases of twenty to thirty pieces or webs of forty to one hundred yards each; cotton thread, tape, paper boxes and packing cases, all stored mainly in the basement or lower floors in cases or on open racks or shelves. Only a few manufacturers in this country use linen in collars and cuffs and some manufacturers claim that good cotton will wear longer and is fully as satisfactory as linen and costs much less. (The cotton and muslin cloth is thirty-six to forty inches wide, both white and colored, and is usually woven specially for shirt and collar manufacturers, the ordinary cloth being twenty-seven to thirty-six inches wide.) Cotton used for the finishing surfaces or "facing" is woven closer and the warp usually contains more picks to the inch, while the interlining is much coarser or heavier. In many instances, bleach (chloride of lime), soap, starch, bluing (aniline blue), parafine or beeswax, and in a few instances dextrine, strawboard, paper and box shooks, are found.

Machinery. Machinery usually consists of the following:

A. Manufacturing processes—
   Cutting machines, knives, dies, presses, and electric cutters.
   Stamping machines.
   Turning machines.
   Stitching and buttonhole machines.

B. Laundries—
   Washers, or dash pots.
   Hydro-extractors or centrifugal dryers.
   Steam-heated dryers.
   Ironers, (gas-heated), hand irons, machine ironers, shirt, collar, cuff.

Processes. The processes are continuous and are mainly interdependent, starting in the basement with the shrinking, and following through the various operations of cutting, stamping, turning,

stitching, laundering, finishing and examining. In some plants box making, printing, and case making are done.

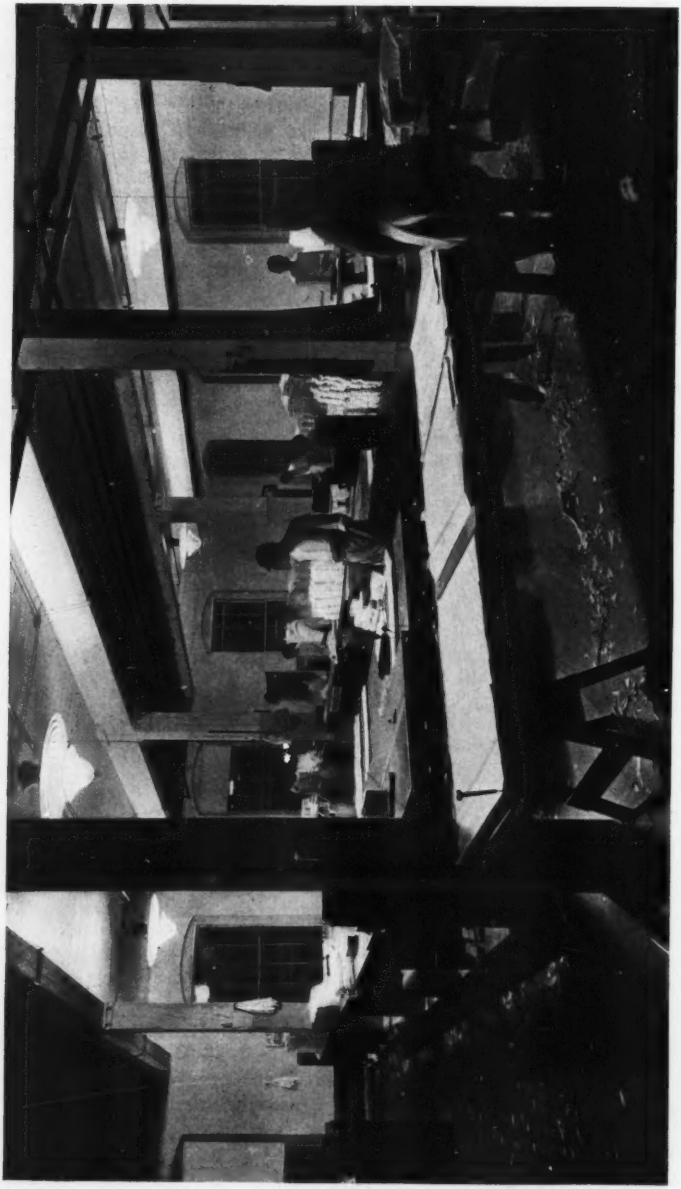
Hazards. The hazards are mainly light except in the box making and printing and may be summarized as follows:—(a) steam-heated shrinking rooms; (b) care of cutting-room waste; (c) gas-heated turning machines; (d) use of gasolene gas from own plant; (e) steam-heated laundry dryers, with or without blower system; (f) coal or gas-heated irons; (g) gas-heated curling or edging machines.

Shrinking. Manufacturers have found shrinking necessary on account of the varying conditions of humidity under which the cloth from the various mills is woven, so as to insure a uniform shrinkage after cutting and finishing, allowance being made in the cutting for a final shrinkage in the laundry. About three-quarters inch shrinkage is allowed per collar. The process is as follows: A piece of cloth, as it is received from the mill, is opened or unfolded, immersed in clear filtered water at the ordinary temperature for a short time, and after passing over a roll to drain off the surplus water, it is hung, without previous wringing in festoons over steam coils in a long narrow drying-room, and a temperature of 100 degrees F. maintained. There are no fans in these dryers, but the festoons are kept in motion mechanically until the cloth is dry, when it is removed and refolded ready for use.

Cutting. The cutting-room is usually located on the top floor, and the shrunk piece goods are spread out on long tables forty to seventy-five inches wide, and fifty to seventy-five feet long and usually thirty-six inches high. Cutting is done by hand, with sharp knives and metal-edged forms or by power presses using dies. If the latter is used the press is stationary at the end of the long table and as the goods are cut a new section of cloth is drawn into position over the cutting-block, which has a series of rollers to allow the cloth to run easily. Machine or die cutting is more expensive than hand work on account of the numerous styles, sizes, etc., in collars and cuffs, and the constant changes in same and the consequent cost of dies. Twenty-four to forty-eight thicknesses of cloth are usually cut by hand; ninety-six by dies. The forms for hand cutting are made of maple, metal bound and are comparatively inexpensive and quickly made. Machine cutting with dies has developed on account of labor troubles and the scarcity at times of experienced hand cutters. Hand cutting is the most satisfactory and makes the least waste. Power machine cutting with dies is only used where the large quantity of a single style will warrant the expense, as dies cost from eight to twelve dollars each. Collars and cuffs are always cut with the warp or length of a piece of goods as the shrinkage is less than across the warp or width, and there is also less waste in the cutting.

The waste from the cutting-tables is thrown under the table and either bagged daily or dropped through wooden or metal chutes to rag-bins in the basement from which they are removed each week and shipped to paper mills where they are made into the finer grades of writing paper.

There is often a considerable value in dies and patterns, but their value is largely problematical and changes with the styles and seasons. These dies and patterns are susceptible to considerable water damage

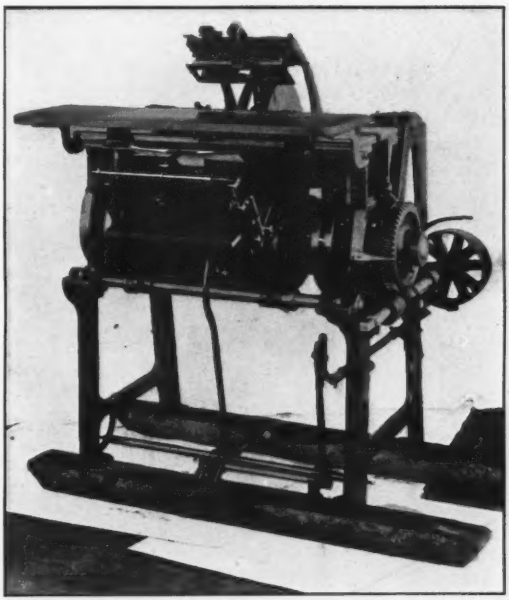


No. 1.—Cutting Room.

and are usually stored in closets or shelves in cutting-rooms, or hung on the walls. Various grades of cotton are used, the better or closer woven varieties being used for the facing or wearing surfaces and the cheaper, heavier and coarser, grades of muslin for the interlining or filling, as it holds the starch much better.

Stamping. After being cut and before being turned, the size, make, quality, and style are stamped on the back of the collar and cuffs with aniline black ink, by stamping machines operated by foot or belt power.

Turning. After being cut and stamped, the cut cloth for collars and cuffs goes through a process called turning. Formerly, this work



No. 2.—Turning Machine.

was all done by hand in the homes, and was a slow, expensive process. A recent invention, however, has completely revolutionized this process and manufacturers are now able to turn out a much greater number of dozens at greatly reduced cost. The increased amount of work turned out is greatly in favor of machine turning, but machine work is limited to certain styles as there are certain curves and shapes that still require hand work. Each collar or cuff is made up of two parts, a front and a back, and in many cases a band, the back or band having been previously stamped; each front and back is also usually made up of two pieces, the edges being turned over a die or templet by an auto-

matic gas or steam-heated folding and pressing machine; these two parts, composed of two pieces each, with the turned edges on the inside are then placed together and stitched along the turned edge and through the interlining thus holding the inner pieces in position. In the case of all hand work, the parts are put together with the outer parts inside and after running are reversed by hand, the band being turned by hand.

The turning machine consists of a flat metal plate either steam or gas-heated, having a collapsible die or templet arms for holding the cut cloth, turning the edges and pressing the same.

Stitching. From the turning department the formed and shaped collar and cuff passes to the stitching-room with its usual long, low tables with stitchers on opposite sides and line shaft running underneath. The individual machines on either side are belted direct from the line shaft and usually run at a high rate of speed with individual clutch or friction control; each line of machines has either individual motors or is belted from the main shaft. The line shaft is seldom enclosed, but is usually left free to prevent the accumulation of lint, dust or rubbish. Shafting and hangers are well looked after as the successful working of the machines depends upon their care and maintenance.

Buttonholes in collars, cuffs, and shirts are stitched and cut on automatic machines all in one operation, either a plain slit or an eyelet hole being cut; in the former case the hole is cut after the stitching; in the latter case, the eyelet hole is first cut and then the buttonhole is stitched.

Shirts. Shirts are divided, generally speaking, into two classes, bosom or stiff shirts and negligee shirts. The manufacture of shirts follows the same general method of that of collars and cuffs except that the body cutting is usually done by electrically operated machines using a reciprocating knife cutting one hundred and ninety-two to two hundred and thirty-eight thicknesses at once; the neck and wristband are made the same as collars, i. e. by turning either by hand or machines. The bosoms are made separately and may be either plain or pleated, in one or two pieces. After the completion of these several operations, the shirt is assembled and stitched.

The laundry operations are the same as for collars and cuffs, except that if hand work is not employed, special heavy machines are required for the distinct operations of ironing the bosom, body, neck and wristband. If hand work is employed, special ironing-boards are used for the bosoms.

Laundries. Up to this point, where the manufacturing operations cease, the hazards have been very light and if the manufacturer has no laundry, where the steam and gas-heated machines (the heaviest hazards) appear, cuffs and shirts are sent away to a public laundry where they are finished, examined, packed, wrapped and shipped to their distributing points. If a laundry is located at the plant, it is usually either cut off or detached from the main plant.

The finished shirts, collars, and cuffs pass through the several stages of washing, bleaching, bluing, starching, drying and ironing. Washing and bleaching are usually carried on in the basement, while starching, drying and ironing are carried on in the upper floors.

Washing. Thorough washing and perfect cleansing are absolute requirements of good laundering, yet a thorough chemical knowledge of bleaching and bluing is the first requisite and while the perfection of modern washing machinery has lightened the labor the personal element enters largely into the work.

No. 3.—Washer Machine.

Forty to three hundred and fifty shirts or two hundred to twelve hundred collars and cuffs are placed in the inner slatted or perforated compartments of a reversible rotary washing machine, or into a compartment of a continuous running dash pot, and the door closed. A quantity of hot water, soap and bleach (chloride of lime), are placed in the body of the washer; the inner compartment is then revolved by power which causes a suction through the slats or perforations thus

forcing out all the dirt and allowing the bleach to act thoroughly. After washing, the goods are rinsed in several changes of water the final rinsing water containing a small amount of aniline blue or purple, as the manufacturer may fancy; this keeps the goods from turning yellow when out of the sunlight. Indigo was formerly used but has long since been superseded by the coal-tar products.

No. 4.—Extracting Machine.

Extracting. After rinsing and bluing, the goods are placed in a centrifugal dryer (Hydro-Extractor) or "devil" and all the surplus water is extracted. This machine runs at a high rate of speed (900 to 1,400 revolutions per minute) and unless well taken care of is a con-

stant source of danger to life as well as to buildings. The machine consists of a perforated inner metal basket revolving in a metal jacket and unless properly oiled and looked after, its peripheral speed of one to one and one-half miles per minute is liable to cause considerable damage.

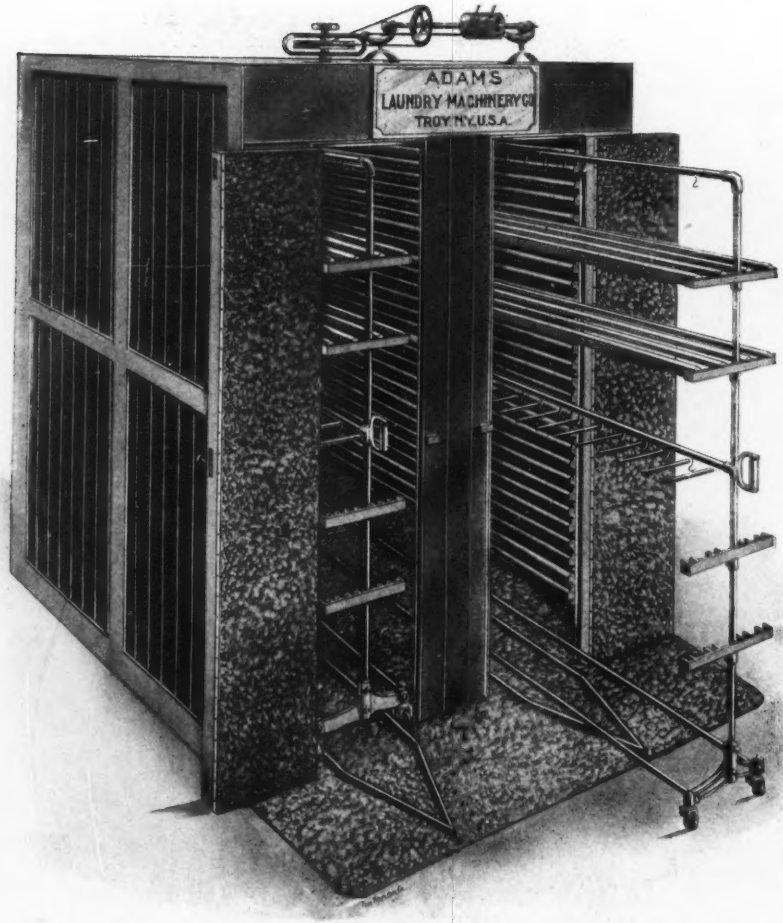
Starching. Before drying, the collars, cuffs, neck and wristbands and bosoms are prepared for stiffening by starching. This has been done more satisfactorily by hand and the better class of work is all hand work. Heretofore machines have not worked the starch into the cloth as well as the hand, yet a machine has been perfected which does the work very satisfactorily and is coming into more general use. Starch jelly is made by dissolving starch in hot water and is used both hot and cold. The use of starch together with wax or gum arabic made possible the high polish so much desired on collars and cuffs, but at the present day the domestic or flat finish is more in demand and the high polish is not so prominent.

Drying. The starched goods are carried to the dryer in baskets on trucks, then hung from drawer racks in steam-heated dry-rooms at a temperature of 150 degrees to 180 degrees F. or hung on trucks which are run into dry-rooms, if the starching department is removed from the dryers, or hung from conveyor chains moving at a slow rate of speed. This latter method allows the goods to dry during one revolution of the chain and permits the addition or removal of goods at any time. In the former case the steam-pipes are usually underneath the drawers, while in the latter cases the steam-pipes are at the sides. In all cases the air is circulated in the dryer by means of a fan usually located overhead with bearings outside of dryer for ease of access in oiling and in case of hot boxes. Dryers may or may not be lined. It is, however, better practice and safer to line the interior of the dryer with a layer of asbestos and lock-jointed tin to prevent a possible charring due to the continued high temperature maintained.

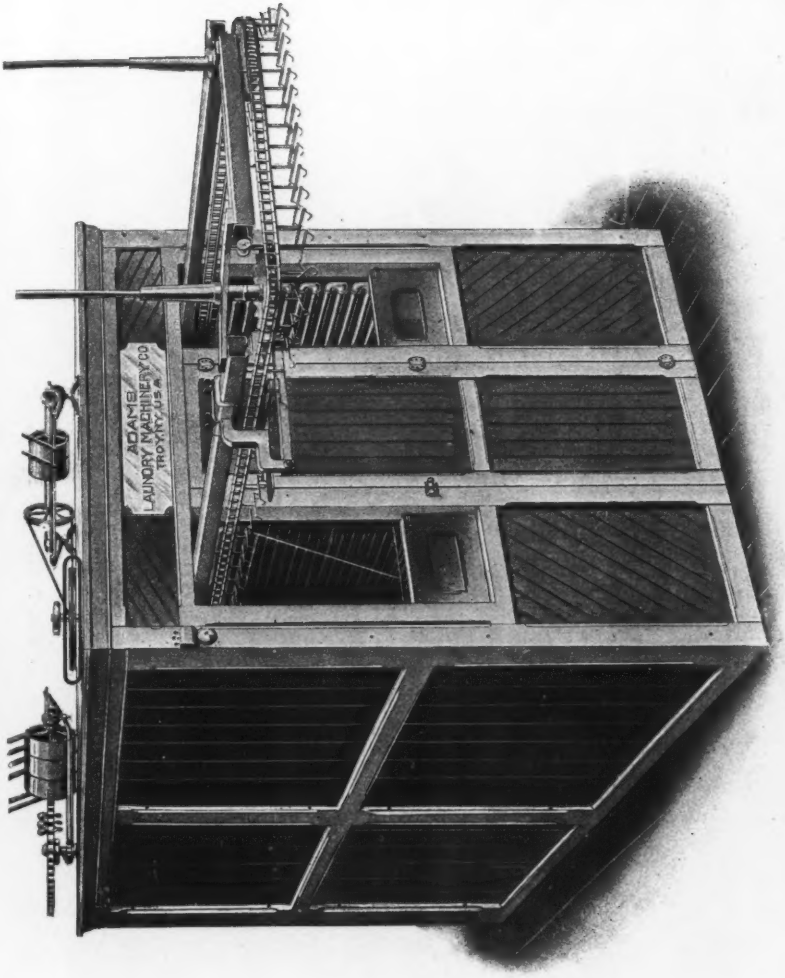
Ironing. After passing through the dryer, the shirts, collars and cuffs are placed in trucks on wheels and taken to the finishing department, where they are ready for ironing. Both hand and machine ironing is employed. Various gas-heated machines are used for bosom, body, neck and wristband, also for collars and cuffs. Special machines are used for dampening previous to ironing, for turning, curling, edge shaping and ironing. Collars and cuffs are usually ironed on gas-heated machines, and special cloth padded tables are provided for shirts with arrangements for holding the neckband and stretching the starched bosom while ironing. A pail of water is at each table—primarily to cool an overheated iron, but is also available in case of fire.

Hand irons either are heated over bunsen burners or contain a bunsen flame with an auxiliary supply of air under pressure. In some few cases the old coal-heated stoves are used, but this method of heating irons has been almost entirely abandoned. Electric irons are seldom used for laundries. All gas-heated machines are vented outside buildings and usually are connected to an exhaust fan.

After ironing, the goods are examined for defects and sorted, counted and packed, one dozen collars or cuffs or one-sixth, one-quarter or one-half dozen shirts in a box, labelled, cased and shipped, or piled

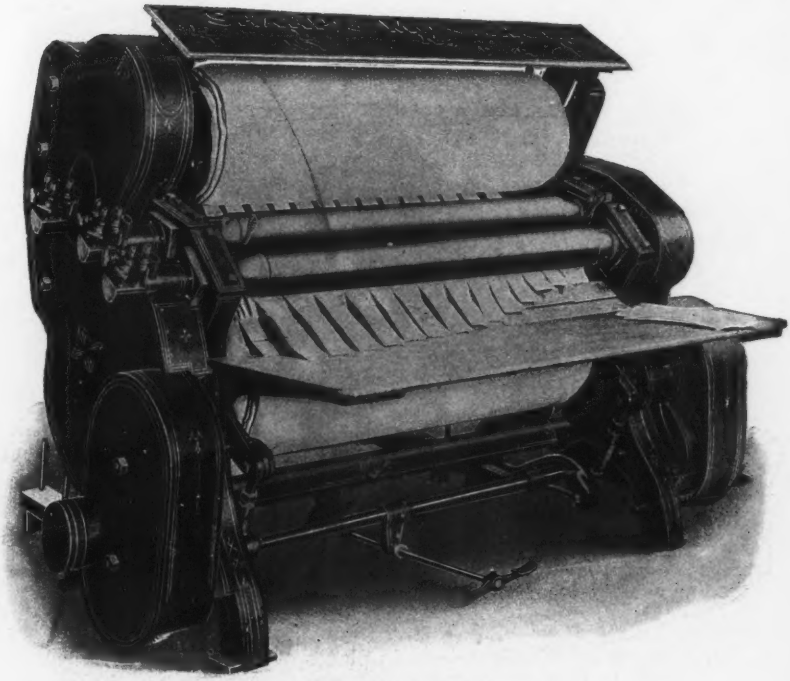


No. 5.—Truck Dry Room.



No. 6.—Conveyor Dry Room.

No. 7.—Ironing Room.



No. 8.—Collar and Cuff Ironer.

on shelves or tables according to size and styles ready for shipping orders.

The employees are largely women or girls, but from the nature of the work it is not necessarily so, men and boys do the work equally as well. Stitching, stamping, collar and cuff ironing and starching are mainly done by women, while cutting, turning and washing are mainly done by men.

About 50,000 dozen collars and cuffs are turned out daily in Troy, N. Y. The majority of factories are equipped with automatic sprinkler systems; usually having two standard sources of water supply, one being an independent pump supply. The care and maintenance is usually good and the fire record is practically **nil**, except from outside exposure.

In conclusion it might be stated that the care and maintenance is usually very good, the nature of the product demanding cleanliness and neatness. The processes are mainly ordinary and familiar and the hazards are mainly light, the heaviest being found in the laundries, where their care and protection are usually well looked after.

Assuming that the majority of plants of this class are equipped with automatic sprinkler systems, which holds true in 95% of

No. 9.—Laundry Stove.

No. 10.—Gas Heater for Irons.

the factories, the defects and suggestions for improvements will be taken up as under that class.

Defects:

The usual prominent defects in plants of this class are:

1. Obstruction to distribution from, (a) stock on shelves or tables; (b) wide cutting tables; (c) stitching tables.
2. Unsprinklered dryers.
3. Gasolene gas hazards.
4. Gas-heated irons with flexible connections.
5. Unlined dryers.
6. Susceptibility of stock to heavy water damage.
7. Hot bearings in dryers—inside bearings on fan shafting often give trouble by heating. The high rate of speed together with the high temperature of the dryers heats up all parts to that temperature so in case the bearings are not properly oiled and become dry they readily heat up to the danger point.
8. Gas-heated turning machines.
9. Storage of patterns, dies and forms, mainly in cutting-rooms.

Suggestions for Improvements:

1. Place sprinklers under all wide shelves, tables, etc.
2. Place sprinklers in all dry-rooms and under all platforms around same, and have same on wet system, with an indicator valve strapped open in an approved manner at a safe distance from the dryer.
3. Line all dry-rooms with asbestos and lock-jointed tin.

4. Have all gasolene drain from building and shut off all gas or gasolene cocks at entrance to buildings at night.
5. Care of irons at night: Either cool all irons by immersion in water, or remove to metal-covered stand or to individual metal stand at heater.
6. Provide automatic damper traps in waste chutes to prevent back draft from waste bin in basement.
7. Skid all stock six inches above floors.
8. Provide waterproof covers for all stock-rooms.
9. Hot bearings. Inside bearings on fans should be entirely done away with and outside bearings used, with adequate means provided for oiling and daily inspection.
10. Arrange for steam heating of turning machine in preference to gas heating.
11. Provide cut-off fireproof storage vaults for all dies, patterns and forms.
12. In addition to fire buckets it is good insurance to have a supply of three-gallon approved chemical extinguishers in all departments.

EDWARD H. KEITH, *Inspector.*

The Underwriters' Bureau of the Middle and Southern States.

Denatured Alcohol.

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PART II.

Its Uses and Possibilities.

The sphere of usefulness of the denatured alcohol bill, which was passed by the Act of Congress, June 7, 1906, has been so materially widened by the amendment which was enacted by this body March 2, 1907, that the important substance of that amendment, which will become effective September 1, is given as follows:—

Domestic alcohol when suitably denatured may be withdrawn from bond without the payment of internal revenue tax and used in the manufacture of ether and chloroform and other definite substances where said alcohol is changed into some other chemical substance and does not appear in the finished product as alcohol. And rum of not less than 150 degrees proof may be withdrawn, for denaturation only, in accordance with the provision of the original act and of this amendment.

The establishment of central denaturing bonded warehouses may be authorized, other than those at distilleries, to which alcohol of the required proof may be transferred from distilleries or distillery bonded warehouses without the payment of internal revenue, and in which distilleries such alcohol may be stored and denatured.

Alcohol of the required proof may be drawn off, for denaturation only, from receiving systems in the cistern room of any distillery for transfer by pipes direct to any denaturing bonded warehouse on the distillery premises or to closed metal storage tanks situated in the distillery bonded warehouse, or from such storage tanks to any denaturing bonded warehouse on the distillery premises, and denatured alcohol may also be transported from the denaturing bonded warehouse or from the distillery bonded warehouse to central denaturing plants, in such packages, tanks and tank cars, as may be prescribed by the Commissioner of Internal Revenue. That is, denatured alcohol may be distributed in tank wagons and tank cars in a similar manner as is kerosene.

At distilleries producing alcohol from any substance whatever, for denaturation only, and having a daily spirit-producing capacity of not exceeding one hundred proof gallons, the use of cisterns or tanks of such size and construction as may be deemed expedient may be permitted in lieu of distillery bonded warehouses, and the production, storage, the manner and process of denaturing on the distillery premises the alcohol produced, and transportation of such alcohol, and the operation of such distilleries, may by certain regulations be exempted from such provisions of the existing laws relating to distilleries as may be deemed expedient by the internal revenue officials.

The following supplemental regulations relating to denatured alcohol are of importance.

In view of the difficulties experienced by wholesale and retail druggists in providing separate buildings or rooms for the storage of denatured alcohol as now required by existing regulations, when distilled spirits, wines, or other

liquors are also sold by such druggists for other than medicinal or mechanical purposes, there may be issued to such druggists permits to deal in denatured alcohol without restrictions as to the place of storage, where, upon careful inquiry made, it shall satisfactorily appear that the applicant is entitled to the full confidence of the Revenue Department, and the sale of such beverage, spirits, wines, or liquors is and will be incidental only to the business carried on by the applicant and that such wines or liquors when sold are not drunk on the premises of the druggist. Manufacturing druggists and chemists manufacturing liquid medicinal preparations, or who, in connection with their general drug business, deal in distilled spirits, etc., may under like conditions as imposed above, obtain permits to deal in and store on their premises denatured alcohol. The privileges here granted will, however, in no case be extended to any manufacturing chemist or druggist engaged in the business of rectifying, purifying, or compounding spirits, wines or liquors.

In view of the difficulty experienced by many retail dealers in procuring small quantities of denatured alcohol in original stamped packages, wholesale dealers, who are also retail dealers, are authorized to sell to qualified retail dealers denatured alcohol in unstamped packages containing less than five gallons each. The alcohol to be sold must be drawn from original stamped packages, to be set aside for that purpose, and each package or container to which such alcohol is transferred must have affixed thereto a label duly signed by the dealer selling the same.

Denatured alcohol intended solely for fuel, light, or power, or for other domestic purposes, may be stored on the same premises with other distilled spirits, wines or liquors, if kept in a room separate from that where such other spirits, wines, or liquors are stored. Where five or more wine gallons of denatured alcohol are stored on such premises, at any one time, the same must be kept in a tank or room securely locked.

To enable manufacturers using denatured alcohol for manufacturing purposes to recover and reuse the same, without awaiting the arrival of an inspecting officer, such recovery and reuse may be permitted where the alcohol is recovered in its original denatured state, or practically so, and is stored, used, and recovered for reuse, in locked or sealed tanks, stills, vessels, or other receptacles connected by continuous closed pipes.

When recovered alcohol is found to require redenaturation the manufacturer will add to such alcohol a sufficient quantity of the approved denaturant, either during the process of recovery, or after the alcohol has been redeposited in the receiving tank. But in such cases the tank or vessel containing the alcohol must be at once locked or sealed by the manufacturer after the required denaturant has been used.

It is plain, therefore, that the Government is trying to make the use of free industrial alcohol a practical fact, and will give to its use all the latitude necessary, consistent with due regard for the protection of the revenue.

It will take much time, it is true, to establish precedents, decide upon and work out details of the best possible manner of applying the law, and prescribe suitable special denaturants in the interests of different technical processes. But that the use of industrial alcohol may revolutionize many industrial processes and give a new stimulant to many trades, now dormant or entirely absent from this country, should be willingly conceded. The use of industrial alcohol is an assured fact and a consideration of its possibilities becomes of great importance.

The uses of alcohol may be considered under the two following classes. 1. As a liquid fuel, for the purpose of producing light, heat and power. 2. As a factor in many technical uses, processes of manufacture, and composition of commercial products.

The former use is the one that the popular mind associates with denatured alcohol and is the one that will appeal most directly to the greatest number of people. In its possibility of displacing gasolene and benzine it probably offers the greatest interest to the fire insurance underwriter and for this reason this use will be discussed with considerable detail in this paper. On the other hand, the latter class of uses offers opportunities for the greatest industrial good, and its latent and unknown possibilities make this class the most inviting for study and research. This class should also be of very great interest to the fire insurance underwriter, because of the new industries and consequent special hazards that it will introduce, as well as reducing important special hazards of many other processes.

The formulas for completely denatured alcohol, it will be remembered, are as follows:—

No. 1	Ethyl Alcohol,	100 gallons.
	Methyl Alcohol,	10 gallons.
	Benzine,	½ gallon.
No. 2	Ethyl Alcohol,	100 gallons.
	Methyl Alcohol,	2 gallons.
	Pyridine Bases,	½ gallon.

Where Formula No. 1 is required in an aqueous solution the benzine of course separates, giving the solution a milky appearance. In this case the other general formula may be used.

It should be noted here that benzine as specified by the Government (the details of which were given in Part I) is, in reality, crude kerosene and does not possess the hazardous features of that distillate commonly known as benzine.

1. The Uses of Alcohol as a Liquid Fuel.

Denatured alcohol general Formula No. 1, will undoubtedly be mostly used as a liquid fuel.

Denatured Alcohol as Fuel for Explosive Engines and a Comparison With Gasolene.

Roughly speaking, gasolene possesses twice as many heat units per volume as alcohol, but it further appears that its thermal efficiency is only half as great. The higher the compression obtained, the greater is the percentage of heat units in the fuel which will be converted to useful work. Gasolene engines cannot be built to work regularly and steadily with compression of more than about eighty pounds to the square inch. Beyond that, premature explosions occur. With alcohol engines a compression of ten or even fifteen atmospheres may be safely used without danger of spontaneous combustion, and in Germany engines work regularly at one hundred and fifty pounds per square inch.

Alcohol requires to vaporize it two and one-half times as much heat per unit weight as gasolene and the water in it requires five times

as much. There is a very much less percentage of heat which goes into the cylinder walls and consequently much less heat to be removed. Also an alcohol engine gives much better efficiency when it is running hot than when it is running cold. The waste heat may therefore be utilized for vaporizing the alcohol, and less power need be expended in operating fans to draw air through the radiators and for pumps to raise the water around the cylinders for the purpose of removing waste heat as is the case with gasolene engines. That is, less heat power is wasted in exhaust gases and in the water-jacket.

Alcohol has, therefore, a greater capacity to absorb heat, it has a lower flash point than gasolene, and preserves a more even temperature, with less loss by radiation. When a mixture of gasolene and air are ignited the gases combine with tremendous rapidity, and much of the power of the explosion is spent in simply giving a blow. The pressure then slacking off immediately. This reaction is so sudden that the energy has not time to be properly transmitted to the moving piston.

Owing to the presence of water in alcohol, the temperature following the explosion is lower because of the absorption of heat by the steam formed at high compression.

By the subsequent expansion of this steam the impulse given to the piston is more gradual and sustained.

Alcohol mixtures require a much higher temperature for ignition than gasolene and in order to obtain the best results a different form of vaporizer or carburetter should be used. Mixtures of alcohol vapor and air are explosive over a wider range of temperatures than mixtures of gasolene and air. The fact that work can be done over a wider explosive range means that the power in the cylinder can be varied and consequently the speed of the engine, merely by letting more or less air into the cylinder along with the fuel. With gasolene the stage is rapidly reached where there is so much fuel that there is not enough air to burn it, or so much air that the explosion is not perfect. This is of tremendous importance to the motor car industry, where efforts are being continually made to render the explosion engine as flexible as a steam-engine, so that by the simple movement of a throttle the speed may be varied from four to fifty miles an hour.

The exhaust gases from the alcohol engine should have practically no odor, if properly operated. There will be some odor from the lubricating oil and some (due to imperfect combustion) if the engine is not properly operated. It is possible to get a larger number of calories, or a greater amount of work, from a given cylinder capacity with alcohol than with gasolene and consequently alcohol engines should sell for less per horse-power than gasolene of the same class.

Theoretically, alcohol denatured with methyl alcohol is open to serious objection. It has been proved by Soret that methyl alcohol, in the presence of air, at a temperature of 480 degrees F. (which is obtained by the mechanical compression of its vapor to ten atmospheres), forms acetone or by-products such as formaldehyde and other substances, and these when they come in contact with the hot metallic surface are oxidised to acetic acid. This would cause pitting of the exhaust valve seat, general erosion of cylinder wall, and give a characteristic odor to the exhaust gases. These deleterious substances might be

split up and carried away by the high temperature of the explosion. However, these adverse conditions depend upon so many factors, such as the temperature of the cylinder walls; whether the carburetter is taking a full, a minimum, or an excessive amount of air; whether the piston is travelling nearly as fast as the explosion; whether it is working under a small or under a large compression; that, from the meagre data to date, no definite conclusion regarding this matter can be drawn. Professor Lucke seems to think that, with proper manipulation, there is no undue corrosion of the interior or no tendency for the interior of an engine using alcohol to become sooty, as is the case with gasolene.

It appears, therefore, that the superiority of gasolene in some respects is offset by the superiority of alcohol in other respects, and their relative efficiencies appear to be about equal. It becomes, then, a question of relative cost plus a number of advantages in favor of alcohol, not influenced by the cost. The Maxwell Briscoe Co. conducted a fuel test of kerosene, gasolene and denatured alcohol, sending three touring cars from New York to Boston, each using one of these fuels respectively. The engine using alcohol was not changed for the test, but was used in the same manner and with the same carburetter as was provided for gasolene. The compression should have been doubled and the stroke increased to have used alcohol to the best advantages. Under these adverse conditions, the data secured show that it would be necessary for denatured alcohol to sell in the market at twenty-two cents a gallon to compete with gasolene at twenty cents a gallon. It is thus apparent that alcohol will not spring into immedate use as a motor fuel. The test, however, proved conclusively that alcohol is a good power producing fuel. It was also found almost impossible to stall the motor, the reason being, as was shown earlier in the discussion that while the initial pressure of the explosion with alcohol is less than with gasolene, the mean effective pressure is greater. In Germany, where alcohol is much cheaper, agricultural motors are being used for all kinds of work where such engines may be used. There the price has fluctuated from thirteen and one-half cents to thirty cents, according to the crops, but has been mostly in the neighborhood of eighteen cents per gallon.

The use of alcohol for engines commends itself to the insurance underwriter for the following reasons: The exhaust gases are not so hot as those from gasolene. The storage of alcohol and its use in engines is much less dangerous than that of gasolene. Alcohol vaporizes much more readily and has a higher ignition temperature than gasolene, and consequently does not form dangerous explosive mixtures in the open air. If it catches fire it may be extinguished by the use of water. This makes it admirably adapted for marine use. The heat from burning alcohol goes upwards mostly in the hot gases which issue from the flame, while a mass of burning gasolene will radiate sufficient heat to set fire to things at a distance from it. The following facts should however be noted: The slight color of an alcohol flame (due to sodium impurities) is practically invisible in sunlight. There is a story told of a man in Paris, whose motor car caught fire and he got into it, and was badly burned, as he did not know there was any fire there at all. The flame being invisible in the daylight makes alcohol in this respect more dangerous than gasolene.

Denatured Alcohol as a Fuel for Lamps and a Comparison with Kerosene.

An alcohol flame is practically non-luminous and cannot be used directly for illuminating purposes. In order that it may be used it must be converted into a vapor and burned in a gaseous state, and the heat resulting from the combustion utilized to produce incandescence in the ordinary mantle which is used in a common Welsbach gas burner. Such a lamp requires a suitable appliance for vaporizing the alcohol. One style of lamp which has given good satisfaction is made in such a form that inside the flame there is a solid mass of copper with conducting pieces going down along with the wick, and the heat carried down these is sufficient to vaporize the alcohol going up.

An alcohol mantle lamp produces a beautiful light to work by and is much less injurious to the eyes than light from kerosene. By its light, silk of delicate shades can be matched and it is so much like mild sunlight that artists can paint by it. An alcohol lamp is much cleaner and does not smell as does a kerosene lamp, and if alcohol is spilled it evaporates without leaving a greasy stain, and if it is set on fire the flame may be extinguished by the use of water. Alcohol lamps may be turned down very low without producing an offensive odor. If the wick is turned high no free carbon (smoke) is deposited as is the case with a kerosene lamp. Practical tests in rough handling and upsetting these lamps, seem to show them entirely free from liability of explosions.

The following tests and results were obtained at the Electric Testing Laboratories, New York City. A Miller thirty-candle power round wick, central draft kerosene was used, this being the best lamp designed for high light-giving and low kerosene-consuming capacity. A "Boivin" alcohol burning lamp with a Welsbach mantle was used. Each of these lamps was found by photometric tests to give slightly over thirty candle-power. The consumption of alcohol and kerosene by each lamp was very carefully noted, with the result that the completed tests show that with an alcohol burning lamp giving 30.35 candle power, a gallon of alcohol would last for fifty-seven hours and five minutes, and that with a kerosene lamp of 30.8 candle power a gallon of kerosene would last twenty-eight hours and forty minutes. This establishes the fact that with the two lamps of an equal lighting capacity a gallon of alcohol will furnish twice as much light as a gallon of kerosene.

Denatured Alcohol as a Fuel for Stoves.

The success of the alcohol stove depends largely upon the character of the wick which must absorb the alcohol and be so adjusted as to give the necessary heating surface. By converting the alcohol into a gas and burning the vapor thus formed the wick may be dispensed with and the more effective burner obtained. Alcohol stoves are intended to be used only as substitutes for gasolene stoves (cooking), oil stoves, open grates, or in places where a small unit of heat is required. Stoves of various sizes are made in Europe. They are simple in construction, easily carried about, and may be used without odor or danger

of explosion in any room. There are also alcohol stoves for heating soldering irons, flat-irons, curling tongs and for roasting coffee and peanuts. Flat-irons are also arranged with a small reservoir, which on being filled with alcohol and lighted, the irons are heated sufficiently for an hour's work. Denatured alcohol is an ideal fuel for the popular chafing dish.

The farmer can no longer claim that he has been deprived of his rights. There are today over one thousand distilleries in the United States in which the daily output is less than thirty gallons. These distilleries, to be sure, are at present engaged in making whiskey or brandy, but so far as the laws are concerned, there is nothing to prevent their manufacturing commercial alcohol. It is now up to the farmer to show what he can do in using his products and producing alcohol at a price that will compete with other kinds of fuel for light, heat and power adapted to farm needs.

The Uses of Alcohol in the Technical World.

In the processes and uses of alcohol enumerated below alcohol has one or more of the following functions:

1. It may be employed merely as a medium in which different bodies are to react upon one another, some medium being necessary because otherwise the reaction would be so violent that in the final product instead of the reaction stopping where one wanted it to stop it would go on beyond that, and one would simply get a mass of useless products.
2. It may be used for the extraction and separation of one or more products from one another.
3. It may be used as a solvent for certain products either in a process of manufacture or where the solution so prepared is an article of commerce.
4. The alcohol radical may be incorporated in the final product as a constituent element.

By the terms of the amendment, denatured alcohol may be used for the purpose of manufacturing ether and chloroform. This is of very great importance to the alcohol industry as the use of alcohol and ether are inseparable in many processes, and ether alone is used in manners similar to that of alcohol as enumerated above in many other processes. In some instances in the following discussion alcohol has been mentioned where ether might do just as well or perhaps be preferred. Indeed free alcohol, without being able to produce ether from it, would be like asking a boy to chop wood without giving him any hatchet. Fusel oil and acetone are also important auxiliaries to the alcohol industry as a whole, and their cheap production depends upon cheap alcohol. They find preference in some industries and may be interchanged in others.

The important uses of alcohol of each class will be discussed in considerable detail. No attempt will be made to differentiate between those that are in actual operation or those that are only possibilities. There are undoubtedly a great number of industries that would now

be using alcohol, but the difficulty in determining this is something like the difficulty of saying whether a child strangled in the cradle would have grown up to be a six-foot man, or a five-foot eight man; you cannot tell what the baby would have done, if it had not been strangled.

Ether is made on a large scale by the action of strong sulphuric acid on ordinary alcohol. The chemical transformation takes place in two steps, there first being formed ethyl hydrogen sulphate which is further acted upon and forms diethyl ether, commonly known as sulphuric ether. It is more volatile than alcohol. The crude ether is purified by shaking with a solution of lime and water, the water taking up the alcohol, while the lime combines with the acid impurity. It is then dried and redistilled. The ratio of alcohol used to ether produced is two to one. That ether commonly known as acetic ether is prepared in the same way from sodium acetate, alcohol and sulphuric acid. It is largely used where ordinary ether is too dangerous. In this respect it stands midway between ether and alcohol.

Chloroform may be made by distilling from iron retorts a mixture of bleaching powder, water and alcohol. The crude product formed is purified by shaking the strong sulphuric acid and redistilling.

Fusel Oil, largely amyl alcohol, is produced commercially only in connection with the distillation of ethyl alcohol, and the quantity produced is therefore dependent on the extent to which the latter material is distilled. It is estimated that in order to secure one gallon of fusel oil, the distillation of one hundred and fifty bushels of grain is necessary, so it can be readily understood that it would be impossible to profitably manufacture it otherwise than as a by-product in the distillation of ethyl alcohol. Cheaper alcohol will, by increasing the supply, reduce the price of fusel oil, and as the alcohol may be substituted in certain industries now using fusel oil this will further have the effect of increasing the present urgent demand for fusel oil and will tend to further diminish its cost.

Acetone, a colorless liquid of peculiar ethereal odor and burning taste and miscible in all proportions with ether, alcohol and water, is now made by the destructive distillation of wood. The pyroligneous acids are neutralized with lime, the calcium acetate so formed is distilled in a dry retort and the acetate recovered by that method and purified. The price of acetone has greatly advanced the last few years. so that it may eventually, with cheaper alcohol, be profitable to oxidise alcohol, produce acetic acid and then neutralize with lime and follow the same operation as above. Acetone has steadily increased in cost along with all wood products. The high price of acetic acid and acetates is also due to the fact that acetate of lime has been so largely used for making acetone for explosive purposes that the quantity of acetic acid made has fallen short.

Acetic Aldehyde, commonly called **Aldehyde** and the oxide of alcohol, is made by treating alcohol with sulphuric acid and potassium bichromate in a hot water bath. Aldehyde is formed, distilled in a somewhat impure state, and purified with ammonia. Aldehyde is used in the manufacture of certain valuable dyes. If added to an ammoniacal solution of silver nitrate, it produces a precipitate of metallic silver which may form a mirror if evenly deposited on a glass surface.

Alcohol itself is also used in the best "silvering" solutions. Aldehyde is very volatile and very inflammable. It may be readily converted into paraldehyde with sulphuric acid. This is a substitute for chloral.

In addition to the two general formulas for denaturing alcohol a number of special formulas have been authorized to be used in the manufacture of certain classes of goods. These will be mentioned in connection with the discussion of the various classes. It does not appear that these special formulas will in any way add to the hazard of using denatured alcohol, only in so far as they will allow the introduction of alcohol into processes formerly employing other substances less hazardous than alcohol.

Special Formula A. As a number of processes have had the following formula prescribed as a specially denatured alcohol, it will be referred to, in order to save repetition as **Special Formula A.** To one hundred gallons ethyl alcohol, five gallons of methyl of the required standard may be added.

The Industry of Resins, Including the Manufacture of Varnishes, Lacquers and Allied Trades.

For the manufacture of shellac or varnish Special Formula A has been prescribed.

There are three classes of varnishes, Linseed Oil, Turpentine Oil, and Spirit Varnishes. Spirit varnishes are solutions of resins such as sandarich, mastic, dammar, gum-lac and shellac in alcohol. The most important is shellac varnish, of which the finest grade is prepared from bleach shellac and copal varnish. The latter is prepared by distilling off all volatile matter, powdering the fused mass and mixing with sand covered with strong alcohol, boiling and then filtering. Colored spirit varnish is made by the addition of alcholic extracts of annatto, dragon's blood, gamboge, tumeric, cochineal or solutions of different coal-tar colors. Spirit varnishes are practically lacquers, but the latter term is more often applied to those varnishes which are applied to metal, and contain resins in a linseed oil varnish thinned with spirit. Cold lacquers are made by using fusel oil, amyl acetate and pear oil. They can be applied to a great many things. Hot lacquers use spirit to dissolve the lacquer, and the spirit is evaporated, leaving a certain amount of colored gum deposited on the metal. Japans are simply varnishes that yield on drying, very hard brilliant coatings upon paper, wood or metal analogous to the natural lacquers of Japan.

Varnish applied in the usual manner is important in the manufacture of pianos, organs, furniture, rattan goods, picture mouldings, frame gilding, burial caskets, cabinet work, passenger cars, wagons, whips, toys, lead-pencils and brushes. Varnish is used to coat the surfaces of linoleum, pegamoid, lincrusta, walton, and similar goods, and for lacquering leather and leather board chair seats. In laying down linoleum, the edge may be cemented to the floor by using a thick solution of shellac and spirit.

Lacquer is used for brass on iron bedsteads, gas and electric light fixtures and apparatus, various kinds of metal hardware, brass goods.

leather trunks, steel pens, etc. By the use of cheap fusel oil the manufacturers of all kinds of lacquer and enameled wares who prefer its use will not have to resort to inferior substitutes, and the public will benefit through securing articles with a more durable finish than that given by the lacquers which have been forced into use by the scarcity of fusel oil

There is an important class of metal varnishes or lacquers such as Zapon varnish, crystalline, Egyptian lacquer, petrifoid, etc., in which pyroxylin is the basis. It is dissolved in alcohol, acetone, amyl acetate, etc. They are of special value for fine metal work in bronze or brass, as they leave a perfectly transparent and flexible film of pyroxylin which protects the metal and will not crack or peel if properly applied. Special Formula A has been prescribed for lacquers made from soluble cotton.

In the manufacture of pastes and varnishes from soluble cotton the following special denaturant has been prescribed. To one hundred gallons of ethyl alcohol shall be added two gallons approved benzol.

The benzol shall be subject to the following specifications: Solubility in water.—When 10 c. c. of benzol are shaken with an equal volume of water in a glass-stoppered cylinder divided into tenths of a cubic centimeter and allowed to stand five minutes to separate, the upper layer of liquid must measure not less than 9.5 c. c. Boiling point.—When 100 c. c. are subjected to distillation in the same manner as prescribed for wood alcohol, not more than 1 c. c. should go over at 77 degrees C, and not less than 90 c. c. at 100 degrees C.

Alcohol is used in the preparation of agaricin, podophyllin, scammony, guiacum and jalap resins as well as other resins and gums. For this purpose Special Formula A may be used. It is used for dissolving resin used for soldering metal boxes.

Shellac is used in connection with the manufacture of black lead inks, sealing wax and grafting wax. Brewers' glaze or brewers' cement is a preparation of alcohol, shellac, etc., which is applied to the inside of the vats, barrels and kegs. It must be able to perfectly cover up the pores of the wood, and not crack off or impart a foreign taste to the beer. Shellac is an important factor as a stiffening in stiff felt, silk and straw hats, in silk, crape and embroidery manufacturing, for making artificial flowers; and in making box toes and counters for shoes. The use of alcohol cut shellac in the hat industry is very important.

The Manufacture of Fur Felt Hats.

Fur from rabbits and similar animals forms the web which is felted.

The very important process of stiffening necessitates the use of high grade and oftentimes bleached shellac cut with alcohol. Alcohol is the vehicle by which the shellac is conveyed into the felt. The hats are dipped in a tank and then scraped until cleaned. The alcohol is then allowed to evaporate or it is recovered in part by a special process of condensation. The average amount of alcohol used per dozen hats is about half a gallon.

Modern hat factories use the Solvents Recovery Apparatus for recovering the alcohol. This consists essentially of chambers into which the hats are introduced and from which a pipe leads to a

surface condensor and a rotary air pump. This pump runs at a speed as high as three hundred and seventy-five revolutions per minute, drawing the vapors over the condensor through which cold water is flowing, condensing the alcohol. The drying and recovery is completed in about three hours, the recovered alcohol has a strength of from 80 to 88%. The alcohol is then sent to a central plant of the Solvents Recovery Co., for distillation to bring it up to 95%.

Patent and Enamelled Leather. Thin split hides of leather are finished with a waterproof and bright varnish surface. They are called enamelled when the leather is finished with a roughened or grain surface, and patent or japanned, when the finish is smooth. Varnish is used in large quantities and in some work amyl alcohol is used as a solvent.

Up to the present time wood alcohol has been used entirely by the hat manufacturers and largely by the painters in spirit varnish and lacquer work. All wood surfaces can be finished more quickly and with much better results where grain alcohol is used. Some persons claim that a good job of rubbing and polishing cannot be done with wood alcohol. In lacquering with wood alcohol there is sometimes a peculiar iridescence caused by the unequal deposition of gum, and some maintain that the lacquer so used will not hold its brilliancy as it will when grain alcohol is the solvent.

The amount of suffering entailed by men working in the hat factories, and by painters and varnishers working on inside work is almost beyond belief. It is of course well known that wood alcohol, when taken internally causes total blindness and often death. But by handling it and working with it in closed rooms men have also been overcome, lost their eyesight, and in some cases have died. It will also produce an irritating rash on the hands and arms of some, to such an extent that they have to cease work.

Manufacture of Vinegar.

Alcohol may be withdrawn from bond, properly denatured, and used for the manufacture of vinegar. The so called Quick-Vinegar Process, is the most important in connection with spirit. Beechwood shavings are placed in large casks or vats having a false bottom upon which the shavings rest. A circle of holes enter the sides below the false bottom. Air vents are placed in the top. The alcohol is poured through and during its oxidation, caused by the acetic ferment from mother of vinegar, considerable heat is evolved; air drawn in at the bottom and passing through the wet shavings aids in the conversion of the alcohol into acetic acid or wood vinegar as it is commonly called.

As acetic acid is necessary in making white lead and acetate of lead, another very large field is open for the increased use of alcohol, and these products should be materially cheapened.

Transparent Soaps.

For the manufacture of transparent soaps the following formula has been prescribed. To one hundred gallons of ethyl alcohol add five

gallons of methyl alcohol of the required standard, one gallon of castor oil and one-half gallon 36 degrees (Be.) Caustic Solution. This is best made by dissolving the castor oil in the methyl alcohol and then adding the soda lye.

Transparent soap can be made very easily without spirit, but the resulting soap is very inferior, and being made by the cold process, contains a very considerable excess of alkali. A certain amount of fatty matter and the very strongest alkali are mixed at a low temperature, and combination takes place. Unless there is an excess of alkali in that soap, it will not become transparent. There is also a large amount of sugar added. Some English soapmakers once notified the English custom authorities of this fact (because England had a duty on sugar), when some cold process transparent soap, made from Chicago by-products, was being sent from this country to England. Some soaps have fats down to 13%, while good soaps may have 85%. This cheap soap is exported in large quantities to the East. It is very deleterious to the human skin. Ignorant people who buy this cold process transparent soap may do a lot of harm to children, especially if they possess delicate skins. Cold process soap costs one-third as much as the transparent soap made of alcohol, but the spirit is necessary to make the finest quality.

Good transparent soap is made in the ordinary way. The soap is shredded and the natural water dried out. It is then dissolved in alcohol and part of the spirit distilled off. The resultant soap and spirit is then cast into blocks and cut up. It has to be kept a long time in order to enable the spirit to evaporate at normal temperatures. As the alcohol evaporates the soap becomes more transparent. Alcohol would be an advantage in the manufacture of ordinary toilet soaps because it has certain influences on the physical nature of the soap which tends to make it a superior article. Grain alcohol allows the use of finer scents and a less quantity of these is required. Up to the present time soap manufacturers have used synthetic perfumes in a more concentrated form of alcoholic solution than they care to do. It would then be evaporated with loss during the process of manufacture. In using scents in this concentrated form it is more difficult to get them evenly distributed in a homogenous product. The presence of the alcohol, which would enable the scent to be more easily distributed through the mass, would also have the effect of helping to break down the crystalline structure of dried soap, tending to produce a more finely finished article, one more transparent, harder, and more durable in use. To produce the same effect so far as possible without using alcohol, it is necessary to "mill" the soap to a considerably greater extent than would be necessary if alcohol was used. This of course means more expense. Transparent soap made with spirit improves with keeping. Alcohol also aids saponification and has the effect of preventing soap from cracking.

A large and growing business has sprung up in manufacturing pure fat, or at least of fat that is edible and pleasant to taste, manufactured from fat that is not so, by extraction with pure alcohol and the removal thereby of the products that are disagreeable to the taste.

Cocoa butter produced automatically in steam-heated presses, in the manufacture of cocoa from cocoa beans, contains substances

similar to acroleine, which must be separated from the fat to make it suitable for ordinary cooking purposes and render it immune to rancidity. This is done with alcohol.

The fat from beef or mutton can be purified in this way, can be used for edible purposes, and would be worth a better price when so purified.

The oil from ordinary cocoanuts when purified by the use of alcohol, may be used as a substitute for cocoa butter.

Alcohol is used in the purification of lanolin. Sheep's wool contains a large amount of fatty matter of a peculiar character. It contains a mixture of fatty acids, free alcohol and esters in the form of true waxes. When purified from fatty acids this wool grease yields lanolin, which has the property of taking up large quantities of water forming an emulsion which is used extensively in medicine.

Alcohol is also advantageously used in refining and washing many raw commercial oils.

Embalming fluid offers an important field for the use of denatured alcohol, and Special Formula A, has been prescribed for use.

Sugar Refining.

Beet-root molasses, which contains impurities in the form of mineral salts and nitrogenous materials, also contains considerable sucrose, 90% of which may be extracted. In the low grade cane-sugar molasses, this cannot be done owing to the presence of invert or reducing sugars. There are several processes, the one that uses alcohol being the Scheibler-Seyferth elution process. A sucrate of lime is formed which is broken up in "Elutors" and then washed with 35% alcohol to free it of impurities. The alcohol may be recovered from the washings by distillation. The washed sucrate is then decomposed with carbon dioxide. This sucrate of lime is soluble in water. Formerly strontium salts were used which are hardly soluble in water, but calcium was found cheaper. This is sometimes spoken of as the emulsic process for extracting sugar from treacle.

Fulminate of Mercury.

For the manufacture of fulminate of mercury the following formula may be used. To one hundred gallons of ethyl alcohol add three gallons of methyl alcohol and one-half gallon pyridine bases of the required standard.

Charges of dynamite and other high explosives are invariably fired by detonators or blasting caps, charged with fulminate of mercury. Also percussion caps, friction primers, and fixed ammunition are charged with this explosive. Fulminic acid is made by the action of alcohol on the nitric acid solution of mercury and from this the highly explosive salt of mercury is made. In the manufacture of the fulminate the stronger the alcohol employed the better the salt obtained. A gallon and a quarter of alcohol is consumed in making a pound of fulminate of mercury. When fulminate is mixed with chlorate of potash and compressed into copper tubes these are known

as detonators. The ordinary class has 80% of fulminate. When the detonators are used for electrical fuses the composition contains 90% of fulminate.

It is a matter of common knowledge that substantially all the fulminate of mercury at present consumed in the United States is manufactured in and imported from Canada.

Nitro-Cellulose Compounds and Allied Products Such as Guncotton, Pyroxylin, Collodion, Celluloid, Etc., and Their Numerous Commercial Forms.

Guncotton is a general name for a series of explosive nitric ethers of cellulose obtained by treating cotton with a mixture of nitric and sulphuric acids. The degree of nitrification can be regulated in a measure and determines the character of the final product. In general, the lower nitrates of cellulose which are insoluble in alcohol and ether are known as guncotton or nitro-cellulose and form the basis of smokeless powders and, when compounded with camphor, of celluloid. The highest nitrates are soluble in alcohol and ether, are known as pyroxylin and these form the basis of collodion, etc.

Smokeless Powders.

The greatest difference between sporting powder and military powder is that a sporting powder should bulk large, and consequently must not become colloidal. Military powder is wanted to suit different guns and must be under control as regards its rate of burning. This can be done only by having a colloid powder, that is to say, a powder which is not porous. Fibrous nitro compounds of the sporting kind when they are first formed into grains are too soft to handle in transit, and it is necessary that they should be hardened. This is done by dissolving more or less of the nitro compound fibre with a solvent of that fibre such as alcohol, ether or acetone, and evaporating the solvent, which leaves the grains in a hardened condition. About 80% of the alcohol may be recovered.

In the military or condensed powders which contain nitro-cellulose of lower nitration, it is necessary to use as a solvent a mixture of alcohol and ether, in the proportion of 60% to 65% ether. It is impracticable in these powders to use acetone as a solvent as that makes the powder too brittle.

The guncotton having been brought into a colloidal condition needs to be dried. The drying of guncotton by heat is a very dangerous process that is almost certain sometime or other to result in accident, because sufficient precaution cannot be taken to prevent small quantities of guncotton dust getting between the boards of the building and onto the heating surface. It is then only a question of time how long it will be before this dust decomposes, for it must decompose sometime unless it is removed. The sensitiveness of dry nitro-cellulose powder approaches that of fulminate of mercury. By the use of alcohol the dangers of drying and of dust may be eliminated.

Two vertical tanks are so arranged that alcohol may be forced through the charge of wet nitro-cellulose. A tap at the bottom is open and gradually the water is forced out until finally all that comes through is alcohol. The alcohol that has been used to drive out the water is also used as a solvent when the ether is added to it. The damp alcohol moistened material need not be centrified, but passed directly to the incorporator.

Cordite is a mixture of a higher nitrated guncotton and nitro-glycerine and is at present made by the use of acetone, but a mixture of alcohol and ether or (possibly) amyl acetate could be substituted. This would be easy to use, and would make a really better powder. Cordite has better all-round keeping qualities than the lower or so-called nitro-cellulose powders.

Smokeless powder made by the use of alcohol is not so stable under the heat test, nor so regular as regards its ballistic properties. The use of free alcohol insures cheapness of production with minimum danger, eliminating the most dangerous operation in the works and the consequent liability of fire and explosion. There is also great saving in the nervous tension of all those engaged in the works because they know a dangerous operation has been abandoned. The Government uses annually over one and one-half million gallons of grain alcohol in making its powder.

Collodion, Etc.

Collodion is pyroxylin dissolved in alcohol and ether forming a colloidal mass. A very large quantity is used in connection with photography directly as collodion, or as an "emulsion" of bromide, chloride or iodide of silver with gelatine for photographic paper and dry plates. The following denatured alcohol formula has been prescribed for the purpose of making dry plates. To one hundred gallons of alcohol should be added one hundred pounds sulphuric ether and ten pounds cadmium iodide. Also Special Formula A, may be used. A gallon and a half of collodion will cover about five hundred square feet of printing paper. Collodion may be shipped in the form of a dry powder, known as Collodion Emulsion Powder and sometimes as Schering's Celloidin, and for use dissolved in alcohol and ether on the premises. The application by the wet plate process of photography to engraving, interests wood engravers and those occupied in allied branches of industry. Alcohol is also used for stripping collodion and for drying plate negatives rapidly as is required in the case of news-press work. Wood alcohol fouls the silver bath, fogs negatives, and makes, in the half-tone process, dots which have ragged, instead of clearly and sharply defined, edges. For photo engraving work the following formula has been prescribed. To one hundred gallons of ethyl alcohol should be added sixty-five pounds of sulphuric ether, three pounds cadmium iodide and three pounds of ammonium iodide.

Celluloid, Etc.

For the manufacture of celluloid and similar products, denatured alcohol having either of the following formulas may be used. To

one hundred gallons of ethyl alcohol add five gallons of approved methyl alcohol and seven pounds of gum camphor. To one hundred gallons of ethyl alcohol add two gallons of approved wood alcohol and two gallons of approved benzol. Celluloid is generally made from nitro-cellulose of fairly high nitrification, incorporated with a definite quantity of camphor. The following, which are more or less well known, are essentially celluloid. Xylonite, Fibreloid, Viscoloid, Pegamoid and Pyralin. Celluloid is used as a substitute for ivory, vulcanite, horn, and coral, and in the manufacture of combs, brushes, mirror backs, photographic films, golf balls and many other well-known articles of commerce. It is also used for making an imitation leather by dissolving old combs and celluloid scraps in fusel oil and amyl acetate, incorporating filling matter and pigments and spreading the mixture on cloth. This amyl acetate, known in the trade as banana oil, is made by treating amyl alcohol and fusel oil with acetic acid. These artificial leathers are sold under various trade names such as pantesote, fabrikoid, keratol, etc.

Artificial Silk.

In France and Germany the artificial silk industry has become well established. Artificial silk has the lustre and general appearance of real silk, is capable of readily taking all shades when dyed and of being woven into fabrics as beautiful as real silk, although it is not quite so strong or durable. Besides using large quantities of nitric and sulphuric acids the process involves the use of a large amount of alcohol and ether. In England an attempt was made to establish the industry, but the high price of alcohol was considered an important barrier, and one of the vital factors which mitigated against its successful issue.

By the process of Chardonnet cotton is converted into nitro-cellulose. After being freed from the last trace of acid, the cotton is digested in a mixture of equal parts of alcohol and ether, in autoclaves. This solution is then driven, under pressure, through fine glass tubes having minute apertures, called spinerettes, into water slightly acidulated. The resulting fibre is wound, the skeins dried and denitrated and then treated as common silk. A little over a gallon of alcohol and ether is necessary for each pound of silk. With untaxed alcohol this industry offers enormous possibilities for development in this country.

Welsbach mantles are now being made of artificial silk, it being considered the best medium for holding the rare earths.

A process was devised for the application of varnish, made with nitro-cellulose dissolved in amyl acetate, amyl formate or acetic ether, for use on mercerized cotton goods, to enhance the effect of artificial silk by adding lustre. A little nitro-cellulose is left on the goods. It was found that the amyl acetate and formate were not satisfactory because of their odor. The use of alcohol as a solvent would obviate this difficulty and with cheap alcohol this process should come into much more general use as mercerized goods have an enormous sale in this country.

Smoking and Chewing Tobacco.

The following formula is used in the manufacture of smoking and chewing tobaccos. To one hundred gallons of ethyl alcohol, add one gallon of a mixture made as follows: Twelve gallons of an aqueous solution containing 40% nicotine, 0.4 pounds acid yellow dye, 0.4 pounds tetrazo brilliant blue 12 B Conct. and water to make one hundred gallons. The determination of nicotine and test for coloring matter must conform to certain definite requirements. Manufacturers of these tobaccos use alcoholic solutions of licorice, maple sugar, glucose, prune juice, etc., for flavoring purposes. The American Tobacco Co. alone has used 5000 barrels of rum, which by using tax free alcohol will mean a saving of nearly half a million dollars per annum.

Shoe Dressing.

Denatured alcohol may be used alone or in combination with other solvents, such as ether, benzine, etc., in the manufacture of blackings, leather dressings, polish or in other liquid preparations which are not used as beverages or for medicinal purposes.

In the purification of rubber, its manufacture and preparation, and in finishing rubber goods, the following special denaturant has been prescribed. To one hundred gallons of alcohol, add ten gallons of acetone and two gallons of petroleum naphtha. The petroleum naphtha must have a specific gravity of not less that .65 degrees or more than .72 degrees at 60 degrees F.

Mechanical Uses.

For making thermometer and barometer tubes, compasses, and other similar instruments, denatured alcohol having the Special Formula A has been prescribed.

Railroads are using denatured alcohol for purely mechanical purposes such as use in hydraulic jacks, automatic signal pipes, etc.

Sanatoriums use alcohol for external applications in baths, for rubbing, etc.

Cheap alcohol and cheap ether should be welcomed by those having need to preserve anatomical specimens, and will have a wide field of use for scientific preparations, preserving specimens for museums, schools, hospitals, etc.

Alcohol instead of water may be used by laundrymen in dampening collars, etc.

As a Cleanser, Etc.

In the manufacture of watches in which a large quantity of alcohol is now used and for which use it is particularly adapted, the following formula has been prescribed. To one hundred gallons of alcohol, add five gallons commercially pure methyl alcohol; one-half pound cyanide of potasssium; one-eighth ounce patent blue B (acid calcium, magnesium or sodium salt of the disulpho acids of meta-oxytetraethyldiamidotriphenylcarbidrids). Best prepared by dissolving the cyanide of potassium in a small quantity of water and then

adding this solution to the alcohol, with which the methyl alcohol, containing the dissolved color, has been previously mixed.

Alcohol may also be used either alone or in combination with ether, benzine, etc., as a cleansing agent and it should have a wide usefulness in this field. Among other uses of alcohol may be mentioned its substitution for benzine in printeries; in shoe shops; tailoring establishments; in the household as a cleanser and remover of grease, paints, stains, etc.; by painters to clean brushes; for cleaning and polishing metals, etc., and it may also be put to many other uses. Large numbers of industries depending on the cleaning of textile fabrics, use alcohol in large quantities.

The Coal-Tar Industry, Including the Manufacture of Aniline Colors, Synthetic Perfumes, Drugs, Pharmaceutical Products, and Incidental Processes and Uses that May Be Mentioned Here.

This department of work offers one of the greatest fields of any that have been discussed for exploitation in the United States.

In the year 1856 while Dr. William Henry Perkin, then a young man, was assistant to Dr. Hofmann at the Royal College, he often worked at home in his own laboratory evenings and at odd moments. At the Easter vacation he was working with a desire to produce quinine artificially from coal-tar. He obtained a somewhat dirty coloring matter which eventually proved to be mauve, produced from aniline. Aniline was previously known to exist only in indigo. This mauve was sold in an alcoholic solution and alcohol was largely used in the early days of the industry as a solvent for extracting the coloring matter from the products with which it was associated, and also as a solvent for the finished products as supplied to the users.

Aniline is a colorless, oily, poisonous liquid and up to this time had been obtained only from indigo by distillation, but is now obtained from coal-tar and nitrobenzine. Chemically, it may be regarded as ammonia (NH_3) in which one hydrogen atom is replaced by the phenyl group ($C_6 H_5$). The final symbol of aniline is $C_6 H_5 NH_2$. After the discovery of Perkin, the business was revolutionized.

In 1866, by the introduction of methyl violet, a demand was created for the raw material, dimethyl aniline, into the composition of which the radical of methyl alcohol enters as a component part. Other important dye stuffs (methylene blue, 1876, malachite green, 1878, etc.) were also derived from dimethylaniline. These coloring matters were the precursors of others such as brilliant green and night blue (1879 and 1883 respectively), of similar type into the composition of which the radical of ethyl alcohol entered and which were derived from diethylaniline. From these two important raw materials, a very great number of dyes are derived. One should not overlook the fact, however, that in the aniline industry as a whole, there are a considerable number of important dyes that do not require alcohol for their manufacture. Prominent among these are the majority of the large class of azo compounds.

Of the six hundred and seventy-three colors mentioned in the

well-known tables of Schultz and Julius about 27% are produced with the help of either methyl or ethyl alcohol. Almost all basic colors are made in this way. There are a large number which while they require alcohol do not require it pure and there is but a comparatively small fraction of the whole number in which the use of pure alcohol is necessary. The following is a list of typical dye stuffs into which ethyl alcohol enters as a constituent. The per cent. of alcohol in some of the most important brands is given. Calculations are made for pure dye stuffs, whilst many of the commercial dye stuffs are more or less diluted with salt or dextrine, and no account has been taken of alcohol lost in the process of manufacture.

These types, monoethylaniline, diethylaniline, ethylbenzylaniline, ethylorthotoluidine, ethylamidophenol, diethylamidophenol, ethyloxybenzydine, diphenetidine, diethylamidobenzaldehyde, tetraethyldiamidobenzyhydrol, are the basis of the following important dyes:

Brilliant Green, 38%, Patent Blue, V, 34%, Acid Green, Ethyl Violet, Fast Acid Violet, Various Acid Violets, Night Blue, Thiocarmine, New Methylene Blue, Night Blue, 2 B, Spirit Eosine, Pyronine B, Rhodamine B, 38%, 3 B, 45% and 6 G, 30%, Quinoline Yellow, Chrysophenine, Diamine Yellow, N, Diamine Scarlet 3 B, Thioflavine, Tetrazine, Auramine G, 40%, Benzopurpurine 10 B, Indazurines, and a number of others. Benzyl Ethylaniline is important in the manufacture of certain greens. Chrysophenine is used in enormous quantities for dyeing cotton, it being a rather fast yellow. This is one of the few azo compounds in which alcohol enters. A great number of so-called diamine colors in the following shades—yellow, red, scarlet and blue; also diamine and diphenyl blacks and many others.

A less amount of alcohol is demanded as a solvent than as a constituent. Solutions of dyes and alcohol contain 30 or 40% of color. Alcohol is required as a solvent in the manufacture of the following: Gallocyanine, Gallanilic Violets, Gallamine Blue, Muscarine, Rhodemine 6 G, Eosine, Anisolines, and many others. Generally the purity of the alcohol is a very important factor when it is used as a solvent The presence of acetone in wood alcohol is very detrimental and tends to form condensation products, which means loss and contamination of the product.

Alcohol is also used as a solvent in extraction of crystallisation of many intermediate products for which the use of methylated spirit (alcohol denatured with wood alcohol) is very unsuitable. As important instances of this may be mentioned the following: Salicylic acid forms the basis of a series of important dye stuffs such as Diamond Black, Alizarine Yellow, Chrysamine, and others. It is also used in large quantities by brewers and others as a preservative agent, also in the manufacture of various salicylates which are largely employed in medicine as well as in the manufacture of many medicinal agents, pharmaceutical preparations and heavy chemicals. Tannic acid in the form of flaky crystals and powder is used as a mordant in dyeing and printing, always for the delicate shades, and also forms the starting point for the manufacture of gallic and pyrogallic acids, the former of which enters into the constitution of a large number of important coloring matters (Gallocyanine, Gallamine Blue, etc.), whilst the latter has a very large sale as a photographic developer. There

is a very large consumption of anthracene brown. It is a condensation product between benzoic acid and gallic acid, and cannot be successfully condensed except with the aid of alcohol. Anthracine brown is a color equally fast against light and milling. Tolidine and benzidine are intermediate products in the manufacture of important dye stuffs. In the manufacture of these, there is a by-product formed (zinc chloride) in very large quantities. For instance, in the reduction of nitro-toluol to tolidine, it has to be reduced by zinc, with which it first forms zinc oxide and then zinc chloride, from which it is recovered. It is used in sizing and possibly for weighting in the cotton industry.

The phthaleins of the eosin groups require resorcinol and phthalic acid or a substituted phthalic acid for their manufacture. In the manufacture of resorcinol ether is used as solvent.

Germans use spirit for dissolving tannin out of the tanning materials and use it on the skin direct. Aniline orange hexanitrodiphenylamine, obtained by treating the low-grade triphenyl rosaniline blues with nitric acid, is largely used by leather dyers for dyeing saddles and similar work because of its special properties. Dyers have to work with india rubber gloves owing to a most virulent and frightful irritation it produces.

The dyers prefer a spirit solution for the reason that it holds the color in solution (some of the colors being absolutely insoluble in water) and when they put it into the dye bath, as the alcohol evaporates the color comes out gradually and goes very evenly over the fibre; whereas, when they have the dye in a watery solution, it rushes on very quickly and they do not give an even shade. With colors in water solutions alone, it is very difficult to get the lightest shades of pink and blue. There were some beautiful dyed goods in the French section of the St. Louis Exposition that were said to be dyed entirely by the use of spirit, obtained as pure as possible, and that they could in no other way obtain such bright and delicate tints.

Alcohol may be found at the textile works for the following purposes. The dyes may go to the factory dry, there to be dissolved in alcohol by the dyers. Alcohol may be applied to the finished products to enhance the fastness or brightness of the color.

Basic aniline dyes are of great importance in the manufacture of lakes (a pigment formed by combining some coloring matter, usually by precipitation, with metallic oxide or earth) for wall-paper, lithographing colors and paints, both delicate and ordinary.

We imported last year from Germany coal-tar colors valued at $14,387,191, and chemicals to the value of $13,389,113, a total of $27,776,304. By the aid of industrial alcohol some, at least, of these chemicals should be manufactured in this country. However, in all fairness to this particular question of the aniline color industry, it should be noted that there are other very important factors which have kept the industry from this country. The United States Government grants a patent that forbids any one to manufacture the product in the United States for seventeen years, while Germany grants a patent on the same article, but provides that it must be manufactured on a commercial scale in Germany within two years, otherwise the patent becomes void. The Germans patent their colors in the United States,

preventing any one from making the colors here, and then they manufacture the colors in Germany. Also the great army of trained research chemists in Germany who work for little or nothing but hope of fame has had a wonderful effect on the development of the aniline dye business in that country.

The manufacture of "synthetic perfumes" must be clearly distinguished from that of "compound perfumes." In the former alcohol enters into the constitution of the odoriferous substance, or is employed as a solvent in its manufacture. In the latter the alcohol is used as a solvent for the odoriferous substances which are compounded and sold in alcoholic solution as a "perfume." This the law strictly says cannot be done with industrial alcohol. The odoriferous substances employed for this purpose may be either natural or artificial products. The following are the most important artificial odoriferous substances called "synthetic perfumes", in the manufacture of which the use of alcohol is necessary and for which Special Formula A has been prescribed. Vanilline, heliotropine, artificial musk, ionine, or violet essence, artificial oil of neroli, geraniol, artificial jasmine oil, and a number of others. These substances are largely used by perfumers, by soap makers, and curiously enough by flower dealers. They are used for scenting natural as well as artificial flowers. The manufacture of synthetic perfumes is difficult and requires the greatest chemical skill and the best mechanical appliances.

Denatured alcohol may be used in the manufacture of solid extracts, resinoids, etc., if the alcohol used in their preparation is evaporated and does not appear in the finished product. A special denaturant will not be allowed unless it can be conclusively shown that the agents used in complete denaturing are absolutely unfit for that line of manufacture. This work may under the law be carried on by a manufacturer of liquid medicinal preparations, but not on the same premises. Solid extracts and like preparations from which the denatured alcohol used has been removed, may be dissolved in tax paid alcohol, and may be used in the manufacture of flavoring extracts, medicines, etc., provided no denatured alcohol is added thereto. Neither completely nor specially denatured alcohol can be used in the manufacture of flavoring extracts, such as essence of lemon, extract of vanilla, etc., or any similar preparation possibly to be used as a beverage or in preparing foods.

The following are some substances in which ethyl alcohol is a necessary factor though its formula is, in them, rearranged, Chloroform, Iodoform and Bromoform (when not made from acetone), Cetarin, Chloralamide, Chloral Ammonia, Chloralorthoform, Eugenol Acetamide, Guaiethol, Methethyl, Paraphenetidine, Nirvanin, Tannoform. Alcohol is very essential in extracting the vegetable alkaloids from such drugs as aconite, nicotine, belladonna, etc.

The following may be mentioned as requiring alcohol either in the process of manufacture, or as a solvent for the finished product. The Glucosides, the Peptones, embrocations, lotions, liniments, and medicines. As an example of the latter may be mentioned Tallianine, which is a terpene with 10% of ozone in solution, and in the manu-

facture of which, a large quantity is necessary. This has been extensively employed in France by veterinary surgeons as a curative for pneumonia. No special denaturant can be authorized for the manufacture of liniments, which are liquid medicinal preparations. Alcohol may be used in the manufacture of plant washes, insecticides, etc., sheep dips, tineacidine, a valuable disinfectant, formaldehyde, one of the finest for sterilizing and disinfecting, and other antiseptics.

Pure alcohol is very necessary in the manufacture of artificial therapeutic agents. At present however the law will not allow the use of denatured alcohol for this purpose. It is to be hoped that arrangement may be effective whereby its free use for these articles may be allowed. For the manufacture of these products pure methyl or ethyl alcohol is required. As an instance of such a compound may be mentioned the important fenfrifuge and antineuralgic known as "Antipyrine," and also as "Acetanilid." It is the methylated condensation product of phenyl-hydrazine and aceto-acetic ether. It is a matter of common knowledge in the trade that Messrs. Meister, Lucius & Bruning, of Hoechst, Germany, made at one time a profit on it alone of $300,000 a year. The patent has since expired.

The following is a list of well-known medicinal agents that require ethyl alcohol in their composition that have not already been mentioned. Acetal, Aconitine, Anaesthesin, Anitipyrin, Atropine and Salts, Bromolin, Butyric Ether, Caffeine, Cantharidin, Chloral Hydrate, Cocaine Hydrochlor, Codethyline, Dionine, Eserine and Salts, Ethyl Chloride, Bromide, Iodide and Formate, Euchinin, Eupyrin, Guaiacol Carb., Holocaine, Homoarecolin, Hydrokinone, Malakin, Malarin, Mercury Ethyl Chloride, Oxalacetic Ether, Phenacetin, Phenazone, Pilocarpine and Salts, Quinaldine, Saliphonin, Santonine, Subcutin, Sulphonal, Tetra-Ethyl Ammonium Hydroxide, Tetronal, Thymacetin, Thymol, Urethane, and Volyl.

The Badische Anilin Und Soda Fabrik have shown the possibility of a large field for using alcohol and ether in the preparation of finer inorganic chemicals. Alcohol and ether are now important in the manufacture of many pyrotechnical preparations.

And finally the following may be mentioned as having found use for denatured alcohol, in other countries, in the process of their manufacture. Electrodes for electric storage batteries, filaments for electric incandescent lamps, Sinili leather, gold beaters skin, corset making (lacquering steels, etc.), brass foundry work, china making, printers' rollers, candle making, artificial lubricants. There are undoubtedly many other uses to which denatured alcohol is being put abroad at the present time and still others which will be developed in the future.

In the production of cold, ether is valuable, and is used in some refrigeration systems. If alcohol be mixed with snow in the proportion of two to one, the temperature of the mixture falls to 5.8 degrees F. Ethyl chloride, which is a by-product in the manufacture of chloral and has an extremely low boiling point (about 52 degrees F), is a good refrigerant. By its use the farmer and others could have a system of domestic refrigeration which would be cheaper than the common anhydrous ammonia system. The degree of cold secured with ethyl

chloride is not so low as that of the ammonia system. It may be recondensed after expansion rather easily. For certain kinds of cooling it gives good results. Pure ethyl alcohol is needed in the Picktet process for making oxygen out of atmospheric air. In Russia denatured alcohol is used to prevent freezing of gas pipes.

Denatured alcohol may be used for ventilating by generating air currents.

In some industries where competition is keen, and close figuring necessary, the price of the prescribed denaturant is sufficient to render the use of denatured alcohol impracticable. To approximate perfection a denaturing agent should be: First, such as to render alcohol non-potable—something which while it disgusts the senses should not produce permanent disability or fatal results. Second, readily soluble in alcohol yet so nearly like it in chemical characteristics as to be with difficulty, if at all, separable from it. Third, of small cost, preferably a by-product of some established commercial process. Fourth, of such a nature as not to interfere with the commercial usefulness of alcohol. Unless systematic effort is made to discover some substance which fulfills all these conditions the manufacture of denatured alcohol is not likely to reach its greatest possibilities. Abroad, bounties have been offered for the best denaturants for specific uses of alcohol. It would be well if the technical industries of this country were stimulated by some such institution as the German Centralstelle, which is a large organization supported in part by the Government and in part by business firms for carrying on scientific technical investigations.

J. ALBERT ROBINSON, *Inspector,*
The Underwriters' Bureau of New England.

Dated, Boston, Mass., March 28, 1907.

The Cement Industry of the United States.

1.—HISTORICAL AND STATISTICAL.

According to advance* statements issued by the geological survey department, the total production of hydraulic cement in the United States in 1906 was 50,027,321 barrels valued at $54,015,733. This represents an increase in both production and value of cement over the preceding year, the increase in production being 9,133,013 barrels.

Of the total amount of cement manufactured in the United States in 1906, 91% or 45,610,822 barrels was Portland Cement with a value of $51,240,652; natural rock cement, 7.9% or 3,935,275 barrels, valued at $2,362,141, and 1.1% or 481,224 barrels of Puzzolan or slag cement, valued at $412,921.

CEMENT.—Defined by one authority as follows:

1. Any composition which at one temperature or one degree of moisture is plastic and at another is tenacious.

2. A kind of mortar which sets or hardens under water; hence often called hydraulic cement.

Cement consists of certain anhydrous double silicates of calcium and aluminum, which are capable of combining chemically with water, to form a hard mass. It differs from lime mortar in that it hardens while wet, does not require the presence of carbon dioxide for hardening, and is very insoluble in water. It is very well adapted for use in moist places, or even under water, and since its hardening is simultaneous throughout the whole mass, and is quite rapid in most varieties, it finds extensive use in building operations.

There are three general classes of cement:

1. Those formed from certain volcanic tufas, or from artificial mixtures resembling these. Such cements generally need the addition of lime before they display hydraulic properties, i. e., form insoluble silicates when treated with water. In this group are the natural volcanic tufas, Puzzolan, trass, and Santorin earth, together with blast furnace slags and certain coal ashes, which are occasionally used.

2. Those which contain a large proportion of free lime, having been made by burning natural argillaceous limestones at a temperature sufficiently high to drive off all the carbon dioxide, but not to fuse the product. These include "hydraulic limes" and Roman cements.

3. Those prepared by burning an intimate mixture of clay and powdered calcium carbonate, at a very high temperature, so that incipient fusion takes place in the mass. These constitute the Portland cements.

RAW MATERIALS IN USE.—Referring to statistics for the year 1905 the production and percentage of total output of Portland Cement in

*Note.—Taken from the preliminary statement annually issued in advance of the complete report on the yearly production of cement in the United States. The advance figures are always issued with the understanding that they may be somewhat increased.

the United States according to type of material used was as follows: 18,454,902 barrels or 52.4% was made from a mixture of argillaceous limestone (cement rock) and pure limestone. This is the combination of materials used in the cement plants of the Lehigh district of Pennsylvania and New Jersey, also in several western plants. 3,884,178 barrels or 11% was made from a mixture of marl and clay, used only in the States of Michigan, Ohio, Indiana and New York. 235,385 barrels or 0.7% was made from a mixture of soft limestone (chalk) and clay. This mixture is employed at plants in Alabama, Arkansas, Texas and South Dakota. 12,672,347 barrels or 35.9% was made from a mixture of ordinary hard limestone and clay or shale. The mixture is employed at many plants all over the United States. Portland Cement made from slag and limestone is included in this group.

From the preceding it will be observed that over half the total product is made from a mixture of "cement rock" and limestone, but this percentage is slowly decreasing. The marl-clay mixture shows a similar decrease. The proportion of the product made from a mixture of hard limestone and clay or shale is, on the other hand, increasing rapidly.

NATURAL CEMENT.—A term applied to the finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the carbonic acid gas. Cements are made in this fashion, by merely burning a naturally clayey limestone in which carbonate of lime and silicates exist in such proportions that, when the carbonic acid is expelled, the lime is exactly in the proportion required to make a hard compound with the silica and alumina; grinding and pulverizing the resulting lumps completes the process. Under the name of Parker's Cement, Roman Cement, etc., such natural cements became widely manufactured and used in England and on the Continent a little over a century ago.

Under the name of Roman Cement it was first made in England by J. Parker, who patented a process for preparing it from the *septaria modules*, consisting of clay and chalk found in the bed along the banks of the River Thames. These rocks are also found in France, Holland and Germany, and in the United States.

In the United States it was first manufactured in 1819, in New York State from a rock found on the banks of Rondout Creek and near the Hudson River, and was called "Rosendale," from the chief town in the district; it still constitutes a large part of the natural cement made in this country. It was extensively used in the construction of the first Erie Canal. Another important region is on the Ohio River near Louisville. Pennsylvania, Illinois, Wisconsin and Colorado also supply much natural cement. The manufacture soon spread over the country, the incentive to this rapid adoption of a new industry being the necessity for using a hydraulic mortar in the locks and walls of the many canals then under construction. The various American natural cements are generally known to engineers by the name of the locality where they are produced. The natural cement industry has shown very slight gains in annual output during the past decade, and at present is almost stationary. During the eighty-eight years of its existence, however, the total amount of natural cement produced in the United States has been very large. New York State, the birthplace of the industry, still leads, though by a steadily les-

sening margin. During eleven years from 1895 to 1906 the total production ranged from a minimum of 4,473,049 barrels produced in 1905 with a valuation of $2,413,052 to a maximum of 9,868,179 barrels produced in 1899 with an approximate valuation of $5,000,000. It will be observed therefore, that there is an apparent falling off in the output of natural cement, but with improved methods of manufacture and more dare on part of chemists and managers there is no reason why this industry should not be placed upon a substantial footing. Natural cement is generally quick setting, and hence is preferred by many engineers for work under water. It weighs from fifty to fifty-six pounds per square foot. Its strength is inferior to Portland Cement. The demand however seems to be mostly for Portland Cement and reports show little indications of any strong revival of a demand for this variety of cement.

Natural cement possesses less strength than Portland and its quality is quite variable on account of the uneven distribution of its ingredients in the natural rock deposits. For making plaster and for mortar or concrete to be used in filling heavy walls, or for brick work in small dwellings, it is freely used as a matter of economy, but should not be relied upon for important structural parts of a building of any size.

PORTLAND CEMENT.—A term applied to the finely pulverized product resulting from the calcination to incipient fusion of an intimate mixture of properly proportioned argillaceous and calcareous materials, and to which no addition greater than 3% has been made subsequent to calcination. Was first patented and made in England in 1824 and so named because of its resemblance when set to a well-known English building stone known as Portland Stone, and coming from the Island of Portland. The industry soon became important in England and extended in a few years to France and Germany. Not until about 1878, however, was there any attempt to manufacture Portland Cement in the United States and for twelve years following the industry grew quite slowly. It was first made at Coplay, Penn. This new agency, however, had the effect of checking the growth of the natural cement industry by reason of the remarkable development of the manufacture of Portland Cement since 1890, as will be observed by statistics referred to later in this paper.

It must be borne in mind that cements that will set under water have not much over a century of recorded use to their credit and are therefore comparatively new products, notwithstanding statements to the contrary. Some authorities claim that the ancients had no knowledge of true hydraulic cements. The mortar used in construction of the Pyramids shows by analysis that it was composed of calcined gypsum or plaster of Paris; many other ancient mortars are of this class, being plasters rather than cements. Ordinary lime mortar has, of course, been in use since very early days, and many famous Roman works were constructed with a mortar which an engineer of today would hesitate to use. Such common lime is made by burning limestone at comparatively low temperatures, just sufficient to drive off the carbon dioxide which it contains. The resulting product—quicklime—will slake violently when water is added and when mixed with water and sand becomes the ordinary lime mortar of the builder.

Other authorities claim, however, that Puzzolanic cements have been

used since the time of the Romans, who were well acquainted with its properties.

Until late in the eighteenth century, about 1795, French and English engineers, working independently, found that when a very clayey impure limestone was burned a very interesting product was obtained. This new material was a true hydraulic cement, for unlike quicklime the burned lumps did not slake on addition of water, but when ground up finely and then mixed with water the mortar possessed hydraulic properties, that is, it would "set" or harden under water.

Portland Cement is manufactured from limestone and clay or shale in some of their many forms. After being mixed in proper proportions, the mixture is finely ground, and then burned almost to a slag, after which the semi-fused product or clinker is reduced to extreme fineness. This outline of the process may appear very simple, but it is one of extreme delicacy, requiring the greatest care throughout in order in insure a satisfactory product. The rapid increase in the value of the production of American Portland Cement during the past twenty years is a feature to which special attention should be drawn. This product was first manufactured in this country about 1875, but as late as 1889 the value of the total annual production amounted to only $500,000. During the next six years, or up to 1895, the value of the production about tripled or amounted in the neighborhood of $1,500,000. Since that date the increase has been marvelous. In 1900 the value of the production amounted to over $9,000,000, while in 1903 it had increased to $28,000,000. The annual production is now roughly estimated in value at $60,000,000.

A geographic distribution of the Portland Cement industry for the year 1905 is given as follows: Out of eighty-eight plants operating thirty-nine were located in the East with an output of 19,589,675 barrels, or 55.6%.; thirty-two plants in Central portion with an output of 10,723,802 barrels or 30.4%; seven plants in the West, with an output of 2,470,349 barrels or 7%; seven plants in the South with an output of 1,237,557 barrels, or 3.5% and three plants on the Pacific Coast with an output of 1,225,429 barrels or 3.5%. The concentration of cement plants is in the so-called Lehigh district of Pennsylvania with its New Jersey Continuation. Here eighteen plants made over 17,000,000 barrels, or about half of all the cement produced in the United States in 1905. This district is the point where American Portland Cement manufacture was first undertaken. Referring to the growth and concentration of this industry it has been stated by one authority that brains and money are more essential to the success of the cement industry than raw material. The eighty-eight plants in existence in 1905 were owned by seventy-eight companies, of which fifteen produced over two-thirds of the entire output while seven of these together produced over half of the entire output of the country.

A word as to the capital invested in this industry. The total authorized capital of all the American Portland Cement plants operating in 1906 would probably be somewhere in the neighborhood of $125,000,000, which cannot be considered as excessive, in view of the fact that it would probably cost $85,000,000 to replace the plants now in existence.

PUZZOLAN OR SLAG CEMENT.—Portland Cement is also manufactured from waste-products of other industries. Among the by-products which have been successfully used for this purpose are included granulated slag of a certain kind from blast furnaces, alkali waste, and the waste slate from quarries and slate dressing mills. Of three materials referred to blast-furnace slag is the most important, and its successful use as a Portland Cement material is worthy of particular attention. Nine plants using blast-furnace slag were in existence in 1905, there being two plants each in Alabama and Ohio and one plant each in Illinois, Kentucky, Maryland, New Jersey and Pennsylvania.

In order to develop the hydraulic property in blast-furnace slag, the melted slag must be cooled suddenly which is usually done by running it into water. The granulated material thus produced is then finely ground and mixed with lime. Some slags contain a high percentage of lime—alumna silicate—and hence need less addition of lime. It is well adapted for concrete work under water or for building foundations, but not for superstructures, on account of its tendency to disintegrate in dry air.

The growth of the slag-cement industry is slow, but the number of plants for producing it is gradually increasing.

F. E. MacKNIGHT, *Chief Inspector.*
The South Eastern Tariff Association.

Note.—In another paper to follow Mr. MacKnight will dwell particularly on the hazards and processes peculiar to Cement Plants. This paper will probably appear in our October issue.—Editor.

Editorials.

As the result of a desire to enlarge the scope of the Quarterly Bulletin issued by the Committee on Special Hazards and Fire Record, and to bring these the Secretary's Bulletins and other printed notices under a single cover we offer to members the first number of a Quarterly Publication devoted to the interests of the Association.

The work of our Association is educational—primarily to our members and secondarily to the public. Through the work of various Committees we have formulated rules and regulations on many subjects pertaining to proper construction and fire protection and large numbers of these rules have been printed and distributed to property owners through the mediumship of the National Board of Fire Underwriters.

The problems of fire protection and prevention are of the utmost importance and not only is our national wealth and prosperity affected by fire loss but many lives are sacrificed. The commercial success of our cities is often jeopardized by dangerous fire conditions. The business of corporations and individuals is often seriously affected or entirely discontinued through loss by fire. When to these we add the many lives at stake in our large stores, our theatres, churches and schools, it becomes a fair question to ask if there is any one subject of more vital importance to this country as a whole than the prevention of and protection against fire.

In this work we have invited the co-operation of all interested in the subject. While the Association was originally started by the Fire Insurance interests, it has ceased to be exclusively an insurance organization and we now include many diversified interests such as,

American Institute of Architects.
American Institute of Electrical Engineers.
American Society of Mechanical Engineers.
American Street and Interurban Railway Association.
American Warehousemen's Association.
American Water Works Association.
International Association of Fire Engineers.
National Ass'n of Master Sheet Metal Workers of U. S.
National Electrical Contractors' Association.

We especially desire the co-operation of the Manufacturers' and Merchants' Associations and their members who represent in great measure the commercial strength of our nation and through whom the greatest good can be accomplished.

The frontispiece shows the street front view of the Engineering Societies' Building which has recently been erected at 29 West 39th Street for the especial purpose of furnishing office facilities for the various Engineering Associations together with assembly rooms and other conveniences going to make up a modern office building of the best type. This building was made possible through the liberality of Mr. Andrew Carnegie and is now in charge of a corporation designed as the United Engineering Association.

On the first floor above the street is a large auditorium with gallery seating about one thousand persons. Above this are two smaller assembly rooms holding from two hundred fifty to four hundred each. There are various committee rooms which can be secured at any time for the work of our Association. In the upper part of the building are located the combined libraries of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and the American Institute of Mining Engineers. This forming the nucleus of what should in time become a great Engineering Library.

Our Association has offices on the eighth floor of this building in charge of Mr. Hugh T. Wreaks, Assistant Secretary. Members are invited to make use of these offices at any time. Copies of all of our publications, rules and regulations will be kept on file.

The subject of Denatured Alcohol is most prominently before us at the present time and merits our most careful consideration. Its advocates claim that through its general adoption and use the fire loss will be materially reduced in that it will to a considerable extent supersede the use of wood alcohol and gasolene (the latter of course including benzine and other light products of petroleum). This on the assumption that denatured alcohol is from the fire standpoint less hazardous than the other compounds noted. If, as claimed, denatured alcohol usually consists of ordinary spirits of alcohol (i. e. ethyl alcohol) with the addition of a small proportion of methyl or wood alcohol with a still smaller proportion of benzine or crude kerosene, it is evident that it would be somewhat less dangerous than those compounds which it is designed to replace in that spirits of alcohol is in some degree at least less volatile, less inflammable, and easier extinguished by water, especially when compared to gasolene and benzine.

The facts as to denatured alcohol particularly as regards the fire hazard must be of the greatest interest to this Association and we have already published three articles on the subject, one by Mr. J. Albert Robinson which appeared in the January Bulletin of the Special Hazard Committee, another by Mr. Nuckolls in the April Bulletin, and a second article by Mr. Robinson in this number of the Quarterly.

According to Mr. Robinson, the hazards attending the use and storage of denatured alcohol are comparatively light, being similar to and not much more severe than those of ordinary grain alcohol, while Mr. Nuckolls is of the opinion that the hazard is considerably greater than ordinary alcohol and approaches that of gasolene. The Committee of Manufacturers who have been prominent in advocating the use of denatured alcohol and who feel that it will be a great boom to the manufacturing interests of this country, take exception to the article by Mr. Nuckolls and in a letter to our Association which has been printed and circularized by them, claim that the fire hazard is not as severe as represented by him. In order to harmonize these differences of opinion and if possible get at all of the facts in the case, a Sub-Committee of the Committee on Special Hazards and Fire Record has been appointed consisting of Henry A. Fiske, Chairman; J. Albert Robinson, A. H. Nuckolls, W. D. Grier.

It is hoped that this committee will consult freely with the Committee of Manufacturers or others conversant with the commercial side of the

question and that finally recommendations regarding the use, storage and handling of denatured alcohol may be published by this Association. The Government has issued a pamphlet entitled "Regulations and Instructions Concerning Denatured Alcohol" and several supplementary circulars, all of which can be obtained from the Bureau of Internal Revenue at Washington.

Mr. Edward T. Cairns, Chairman of the Committee on Fire Proof Construction, has the following to say with reference to fires in so-called fireproof buildings. The subject was discussed to some extent at the annual meeting of our Association and an endeavor will be made to obtain reports on fires in this class of risk in a similar manner to the plan now used in obtaining data on fires in manufacturing risks and sprinklered risks.

"The necessity of more complete and accurate data on the subject of fireproof building construction is becoming more and more apparent as the erection of so-called fireproof buildings increases, and the types and systems of such construction multiply.

The tremendous increase, during the past few years, in such buildings, induced perhaps quite as much by the demand for spacious light and high offices or mercantile houses in large cities, and by the diminishing conditions in cost between inflammable and non-inflammable building materials, as by a serious desire for really fireproof qualities, requires a concerted effort at a more thorough study of the comparative merit of various styles of construction than has ever yet been attempted.

The conflagrations of Baltimore and San Francisco have afforded excellent opportunities to study the effects of conflagrations on fireproof construction, but do not afford a basis for proper conclusions as to what would be the result of fires under more ordinary conditions. It is true, of course, that there are records of a good many fires, of varying degrees of importance, but they have apparently never been tabulated, and probably, in a great majority of cases, the details are known only to a comparatively few people.

The result of the National Fire Protection Association's work in investigating and reporting fires in sprinklered risks has been so satisfactory that it would seem as though an investigation of fireproof building fires upon somewhat the same plan should be equally interesting and instructive. Blanks can be prepared and distributed on which members are urged to report in detail all fires, whether large or small, in any sort of building claiming fireproof classification. There will doubtless be some difficulty in making a tabulation of this sort, and it is not expected that any statistical tables of losses alone will measure accurately the value of various sorts of construction, but the gathering and publication of full details showing the effect of fires on various building materials, and the ability of such materials to retard or prevent spread of fire among inflammable contents or to adjacent structures cannot fail to be very helpful in measuring the real value of so-called fireproof construction."

The Fire Record of various classes of Manufacturing Risks which have been published in the Quarterly Bulletin, that on Clothing Factories

being in this number of the Quarterly, must be of considerable interest to those who are studying the cause of fire and methods of protection. The fact however that the tables are necessarily somewhat lengthy and more or less complicated may decrease their value to our members as a whole. In order to bring out more fully some of the salient points we will from time to time give brief summaries of all classes so far reported upon.

Table No. 7 gives the effect of sprinkler protection in various classes of occupancy and while it is of course evident that the character of the equipment itself has generally more to do with the effect of the sprinklers than the nature of the occupancy, the tables are nevertheless instructive especially if studied in connection with the specific causes of unsatisfactory fires as given in the Quarterly.

Table No. 11 can also be noted in this connection as showing the average number of sprinklers opened in the satisfactory sprinkler fires, this tending to show the probabilities of opening a large number of sprinklers due to quick spreading fires, obstruction to distribution, etc.

TABLES 7 AND 11.

	Wholly Successful.	Held in Check.	Unsatisfactory.	Per cent. of fires extinguished by one sprinkler.	Average No. of sprinklers opened.
Shoe Factories	78%	19%	3%	48%	3.0
Furniture Factories	56	31	13	25	10.6
Paper Mills	64	28	8	25	12.1
Sulphite Pulp	47	26	26	10	20.4
Planing Mills	49	35	16		
Wood Box Factories	41	47	12		
Misc. Tenant Woodworkers	61	35	4		
Sash, Door and Blind Fact.	59	29	12	18	8.8
Wood Turning	54	38	8		
Pail Factories	45	36	18		
Flour Mills	47	41	12		
Cereal Mills	59	18	23	8	18.4
Grain Elevators	37	31	31		
Foundries	43	46	11	19	6.0
Saw Mills	33	36	31	8	23.5
Printers	77	18	5	52	3.2
Clothing Factories	82	14	4	40	5.0
Total Percentage	63%	28%	10%	30%	7.3

Note:—Average number of sprinklers opened does not include unsatisfactory fires.

Attention has often been called to the need of outside shut-off valves to control gas supply to buildings, especially buildings located in congested districts of cities or where other property is endangered. There have been many fires which have become serious and spread beyond the control of the fire department due to the fact that there was no way of shutting off the gas supply. Gas piping is frequently broken when fire is still, comparatively speaking, in its incipiency, the meters or connections melt or are broken and the result is a large volume of an exceedingly inflammable gas pouring into the burning building with no means at hand of preventing the flow. Such a fire is difficult if not impossible of extinguishment and it seems remarkable that the city authorities do not all recognize this danger and legislate in favor of properly located shut-off valves.

The "QUARTERLY" should be the mouthpiece of our Association. Members are requested to send in articles, notes, reports on fires, or any other subject matter pertaining to Fire Prevention and Protection.

Address the Editor, National Fire Protection Association, P. O. Box No. 1284, Hartford, Conn.

Secretary's Report, Branch Offices and Underwriters' Laboratories.

In addition to the principal office and testing station at Chicago, the Laboratories have installed branch offices in a number of the principal cities, the locations of which are given below. Members of the Association and others interested who live in the vicinity of any of these branch offices and desire to get into touch with the laboratory work, or make inquiries in reference to any department of the laboratory service, can do so by calling upon or writing the engineer in charge of any of these branch offices:

BRANCH OFFICES.

New York, 29 W. 39th St.	St. Louis, 1004 Century Bldg.
Boston, 93 Water St.	Cincinnati, 1403 First Natl. Bank Bldg.
Philadelphia, 137 So. Fifth St.	Columbus, Ohio, Outlook Bldg.
Schenectady, 434 State St.	Buffalo, 110 Pearl St.
Pittsburg, 336 Fourth Ave.	Indianapolis, Lemcke Bldg.

Arrangements are under way for offices at New Orleans, Kansas City and San Francisco.

The Committee on Devices and Materials has before it suggestion from the Laboratories for issuance of list of manufacturers at present turning out metallic window frames for wired glass strictly in accordance with the National Fire Protection Association requirements. The companies who are thus far qualified to have their names upon such list are as follows:

Thomas Lee, Cincinnati, Ohio.
David Lupton's Sons Company, Philadelphia, Pa.
J. C. McFarland & Co., Chicago, Ill.
Sykes Steel Roofing Company, Chicago, Ill.
Witt & Brown, Cincinnati, Ohio.
Knisely Bros., Chicago, Ill.
Zahner Mfg. Company, Kansas City, Mo.

All approved windows shipped from these factories bear metal labels reading:

WINDOW FRAME
For Wired Glass,
Constructed under Supervision of
UNDERWRITERS' LABORATORIES, INC.
No.

It will be remembered that these windows are rated in the Association rules as suitable for protection against moderate exposures when they are properly glazed and installed, and that the question as to what constitutes a moderate exposure is in all cases to be determined by the underwriters having jurisdiction.

A special committee has been appointed by the National Board of Fire Underwriters to visit the Laboratories in September for the purpose of reviewing suggested plan for enlargement of the plant and scope of the laboratory work to embrace examination and test of structural methods and materials. The Structural Materials Testing Laboratory of the United States Geological Survey at St. Louis, has been conducting its tests for fire retardant qualities of cement blocks, limestone brick, and other building material at the Underwriters' Laboratories, Chicago, using the ovens erected there, which have been found so efficient in connection with the test work on fire protection coverings for window and door openings. These tests have been going on since Spring, and it is expected that the results will appear among the department's publications in due course.

The following are current prices of publications which have been issued by the Association. They can be obtained either from the Chicago or the New York Office.

Proceedings	Volume	1	.15
"	"	4	.20
"	"	5	1.00
"	"	6	5.00 (on account of the limited number on hand.)
"	"	7	1.00
"	"	8	.25
"	"	9	.25
"	"	10	.25
"	"	11	1.00

Special Hazard Bulletins		Nos. 1, 2, 3, 4, 5 and 6 each	.20
" " "		No. 7	.30
" " "		No. 8	.35
" " "		No. 9	.20
" " "		Nos. 10, 11, 12, 13, 14, 15 each	.25
" " "		No. 16	.30
" " "		No. 17	.25
Secretary's Bulletins		Nos. 37, 54, 73, 74, 76, 85, 90, 91 each	.20
" "		except as noted above each	.05

Committee Reports:

Baltimore Conflagration (second edition without map)	.15
Relative Fire Hazard of Cotton as Baled by Various Methods	.25
All other matter published to date including bulletins, rules and reports	.02 to .04 postage.

MEMBERS ELECTED, ACTION OF EXECUTIVE COMMITTEE, JUNE, 1907.

ACTIVE.

Mainland Fire Underwriters' Association of British Columbia, A. W. Ross, Secretary, Vancouver, B. C.

ASSOCIATE.

Mr. L. F. Baldwin, Inspector, Inspection Department Factory Mutual Fire Insurance Companies, 31 Milk Street, Boston, Mass.
Mr. H. Billetter, Deputy Manager, Lumber Underwriters, Room 1200, 66 Broadway, New York, N. Y.
Mr. Harry Atwood Burnham, Inspector, Factory Mutual Fire Insurance Companies, 31 Milk Street, Boston, Mass.
Mr. Wm. J. Chattin, Inspector, Associated Factory Mutual Fire Insurance Companies, 111 East Mount Airy Avenue, Philadelphia, Pa.
Mr. Clyde E. Culp, Inspector, Underwriters' Bureau of Middle and Southern States, 71 William Street, New York, N. Y.
Mr. Geo. E. Fisher, Special Risk Department, Hartford Fire Insurance Company, 16 Grove Street, Natick, Mass.
Mr. C. B. G. Gaillard, Supt. of Agencies, The Colonial Assurance Company, 45-49 Cedar Street, New York, N. Y.
Mr. J. V. W. Griswold, Special Agent, Liverpool & London & Globe Insurance Company, Box 925, Dallas, Texas.
Mr. W. G. Hall, Inspector, Commonwealth Insurance Company, 23 Liberty Street, New York, N. Y.
Mr. F. M. Heermann, Special Inspector, Associated Factory Mutual Fire Insurance Companies, 31 Milk Street, Boston Mass.
Mr. Geo. F. Hiller, Inspection Department, Associated Factory Mutual Fire Insurance Companies, 31 Milk Street, Boston, Mass.
Mr. John A. Hougaard, Special Agent, North British & Mercantile Insurance Company, 2291 Howard Street, San Francisco, Cal.
Mr. William O. VanDerVoort, Special Agent, Williamson Bldg., Cleveland, Ohio.
Mr. Chas. E. Wickham, City Manager, City of New York Insurance Company, 42 Cedar Street, New York, N. Y.
Mr. William P. Young, General Agent, North British & Mercantile Insurance Company, 76 William Street, New York, N. Y.

SUBSCRIBING.

Mr. O. J. Burkhardt, Surveyor, Sanborn Map Company, 63 Market Street, Chicago, Ill.
Mr. A. L. A. Himmelwright, General Manager Roebling Construction Company, Box 69 Madison Square P. O., New York, N. Y.
Mr. N. V. Holmes, Fire Marshal, Sears, Roebuck & Company, Homal and Harvard Avenues, Chicago, Ill.
Mr. Hervey Mason, Jr., Automatic Sprinkler Engineer, 555 Lebanon Street, Melrose, Mass.

Mr. Geo. L. Patterson, President, Stanley & Patterson, 23 Murray Street, New York, N. Y.
Mr. Howard R. Sargent, Engineer Wiring Supplies, General Electric Company, Schenectady, N. Y.
Sieben Chemical Nozzle Company, 212 W. 12th Street, Kansas City, Mo.
Mr. W. T. Small, Instructor, Purdue University, 427 Russell Street, West LaFayette, Indiana.
Mr. Hans C. Toensfeldt, Structural Engineer, Board of Education, 410 Board of Education Building, St. Louis, Mo.
Mr. S. F. Weston, Eastern Representative, Phoenix Fire Extinguisher Company, 44 East 23rd Street, New York, N. Y.
Mr. Jas. G. Wilson, President Jas. G. Wilson Manufacturing Company, 3 W. 29th Street, New York, N. Y.

Clothing Factories---Fire Record.

Total Number of Fires, 125.

1. CLASSIFICATION OF CAUSES.

Common Causes.

LIGHTING. Number of fires, 6.
- Carelessness in handling of open torch.
- Curtain string blew into gas-flame.
- Started around gas-meter in small closet.
- Engineer repairing motor ignited dust in enclosure with a candle used for light.
- Overturning of watchman's lantern.
- Spark from match in lighting gas-jet over box of clippings ignited same.

HEATING. Number of fires, 3.
- Heat from stove ignited woodwork.
- Overheated furnace ignited woodwork.
- Room newly painted, gas-stove left burning to dry paint ignited paint fumes.

POWER. Number of fires, 2.
- Caused by ground or short circuit in molding under starting box of motor.
- Hot shafting at floor ignited waste clippings from garments.

BOILER (or fuel). Number of fires, 3.
- Hot ashes placed on truck ignited same.
- Oil dripping from floor above onto hot boiler ignited.
- Started in box of shavings in boiler room.

RUBBISH (or sweepings). Number of fires, 8.
- Spontaneous combustion in rubbish and sweepings, 7.
- Spontaneous combustion in refuse bin.

OILY MATERIAL. None.

SMOKING. Number of fires, 10.
- Employee threw away cigarette when leaving.
- Cigarette thrown into box of rubbish.
- Match or lighted cigarette falling into loose paper.
- Cigarette dropped in waste basket.
- Carelessness of employee in dropping match after lighting his cigar.
- Lighted cigar dropped in elevator well.
- Cigar stub thrown into pile of linings.
- Caused from smoking in basement.
- Matches or cigarette dropped in waste material box.
- Fire caused from smoking.

LIGHTNING. Number of fires, 1.
- Lightning entered basement on electric light wires.

MISCELLANEOUS. Number of fires, 2.

Spontaneous combustion in a wooden box filled with sawdust used for a spittoon.

Spontaneous combustion of rags used in rubbing office furniture with linseed oil and turpentine.

Special Hazards.

STOCK FIRES. Number of fires, 2.

Spontaneous combustion of dyed stock.

Fire in bale of cotton wadding.

CUTTING-BOARDS Number of fires, 1.

Spontaneous combustion of linseed oil rags and cutting-board scrapings.

WASTE CUTTINGS. Number of fires, 16.

Spontaneous combustion of waste materials and cuttings.

SAD IRONS (or tailor's goose). Number of fires, 18.

Electric-heated irons, 5.

Electric wires ignited wood support covered with asbestos.

Caused by electric iron.

Overheating of electric pressing iron.

Current left turned on sad-iron.

Current left on electric iron.

Gas-heated irons, 8.

Workman left pressing iron on table top with gas burning.

Gas-heated sad-iron left burning and becoming overheated ignited bench.

Overheated gas-iron, employee left gas turned on.

Employee left gas burning, rubber tubing burned off and ignited table.

Defective gas tubing on small machine for ironing.

Gas-heated iron placed on table without required iron stand: iron ignited the woodwork.

Gas-heater for pressing irons left burning which ignited table and cuttings.

Caused by gas-heated pressing iron.

Stove-heated irons, 3.

Explosion of gasolene stove used for heating flat-irons.

Ignition of gasolene condensed in tubing to heater.

Caused by gasolene stove for heating pressing irons.

Charcoal-heated irons, 2.

Spark from tailor's goose lodged in box of charcoal.

Fire in box of charcoal used to heat sad-irons.

WASTE CHUTE. Number of fires, 1.

Spontaneous combustion of oily material in waste chute.

Summary.

	Number Of Fires.	Per Cent Of Whole.
Common Causes.		
Lighting	6	8.2
Heating	3	4.1
Power	2	2.7
Boiler (or fuel)	3	4.1

		Number Of Fires	Per Cent. Of Whole.
Rubbish (or sweepings)		8	10.9
Oily material		0	
Smoking		10	13.6
Lightning		1	1.4
Miscellaneous		2	2.7
Total		35	
Special Hazards.			
Stock fires		2	2.7
Cutting-boards		1	1.4
Waste material		16	21.9
Sad-irons (or tailor's goose)		18	25.
Electric-heated irons	5		
Gas-heated irons	8		
Stove-heated irons	3		
Charcoal-heated irons	2		
Waste chute		1	1.4
Total		38	
Common Causes		35	48
Special Hazards		38	52
Total		73	
Incendiary		0	
Exposure		1	
Cause Unknown Fires		51	
Total Clothing Fires		125	

2. DETAIL OF CAUSES.

Common Causes.

S-3896. Engineer repairing motor ignited dust in enclosure with a candle used for light.

Special Hazards.

H-269. Silk neckties are cut out on a cutting-board similar to those employed in shoe factories which is oiled and scraped the same way.

These cuttings and rags by which the linseed oil dressing is applied were placed outside on the fire escape. At 10:30 at night a policeman passing the end of the street saw them in a blaze and called the department who extinguished the fire before it entered the building. The window casings were damaged, however.

H-322. Although the electric current was cut out at six o'clock p. m. it is thought that before that time the wooden asbestos-covered rest for electric-heated irons had ignited and smouldered until near the time when the fire was dicovered.

"Rests" for hot irons should be made entirely of incombustible material, with a circulation of air underneath and no woodwork exposed to heat.

S-512. Overheated gas-iron: workman left gas lighted, rubber tubing burned off igniting table.

H-712. Gas-heated sad-iron left burning when shop was closed became overheated setting fire to bench.

S-2590. Fire started in wooden box about 1'x2'x1' containing charcoal. It was situated under a bench about four feet wide and twenty feet long. The charcoal was used to heat sad-irons, it being burned inside of large irons. Each night the charcoal was removed from the irons, put in a metal barrel, and then wet down. Metal barrel was located under the bench a few feet away from the charcoal box.

Irons had been used during the afternoon and it seems likely that a spark got into the charcoal box in some way, probably when the irons were being cleaned.

S-3241. The gas-heated irons were placed on a table without the required stands under them and thereby caused the fire.

3. ROOMS IN WHICH FIRE OCCURRED. (Not Tabulated.)

4. DAY OR NIGHT. (Day Fires, 6 a. m. to 6 p. m.)

	Special Hazards.		Common Causes.		Unknown.	Total Fires.	
	No.	Per Cent.	No.	Per Cent.	No.	No.	Per Cent.
Day	7	18	6	17	12	25	20
Night	31	82	30	83	37	98	80
Total with data given	38		36		49	123	
No data	0		0		2	2	
Total	38		36		51	125	

5. PLANT IN OPERATION.

	Special Hazards.		Common Causes.		Unknown.	Total Fires.	
	No.	Per Cent.	No.	Per Cent.	No.	No.	Per Cent.
Plant in operation	8	23	6	19	8	22	19
Plant not in operation	27	77	25	81	40	92	81
Total with data given	35		31		48	114	
No data	3		5		3	11	
Total	38		36		51	125	

6. HOW DISCOVERED.

	Special Hazards.		Common Causes.		Unknown.	Total Fires.	
	No.	Per Cent.	No.	Per Cent.	No.	No.	Per Cent.
Employee	8	21	8	22	11	27	22
Watchman	8	21	5	14	6	19	15
Thermostat	5	14	3	8	10	18	14
Sprinkler alarm	8	21	12	33	14	34	28
Outsider	8	21	8	22	9	25	20
Total with data given	37		36		50	123	
No data	1		0		1	2	
Total	38		36		51	125	

7. EFFECT OF SPRINKLERS.

	Number Of Fires	Per Cent. Of Whole.
Extinguished or practically extinguished fire	82	82
Held fire in check	14	14
Unsatisfactory	4	4
Total	100	

8. DETAILS OF UNSATISFACTORY FIRES.

1046. July 16, 1900. Chicago, Ill. Sprinklers shut off at time of fire for some unknown reason. Fire was on the fifth floor and was discovered by watchman who rang in street box. Fire was controlled by the city fire department.

Summary: Water shut off sprinklers.

1701. January 5, 1902. New York, N. Y. Brick building, seven stories, occupied for tenant manufacturing. Wood floors, open joist ceiling. Fire started on top floor used for manufacturing suspenders, cause not known. Discovered by employee. Harkness Tee Electric sprinkler alarm did not operate. Risk equipped with Grinnell glass disc sprinklers, supplied by a 5,000 gallon gravity tank twelve feet above. Wet system. Sprinklers spaced eight feet across joists, lines being twelve and one-half feet apart lengthwise with joists; old pipe sizes. Sprinklers failed to hold fire in check; roof burned off causing total loss on top floor and also loss on lower floors from water. The three-inch drop from the tank was badly exposed and as fire occurred in midwinter it is possible that water was at least partly frozen in this pipe. The failure of sprinklers to hold fire in check may be attributed to light water pressure and light spacing, also small size of feed pipe.

Summary: Light water pressure and defective spacing.

3554. February 12, 1905. New York, N. Y. Brick tenant manufacturing building six stories high, ordinary joist construction, single floor, lath and plaster ceilings. Manufacturing clothing, shirts, etc. Fire occurred around elevator shaft on third, fourth, fifth and sixth floors and burned through the roof. Risk was equipped with Gray sprinklers installed in 1890, 106 on top floor spaced 8'x11' on smooth ceiling. Wet

system supplied by 10,000 gallon gravity tank eleven feet above top lines. Unapproved Gray sprinklers slow in opening. The construction of the elevator shaft was such as to enable fire to spread rapidly to floors above and to roof, thereby opening a large number of sprinklers and quickly draining tank. For further details see Sprinkler Fire No. 89, Page 45, April, 1905, Bulletin.

Summary: Floor openings.

4585. October 6, 1906. Louisville, Ky. Full details of this fire are given in the January Bulletin, 1907. It appears that sprinkler system must have been shut off at time of fire, otherwise there is no satisfactory explanation of the failure of sprinklers to hold fire in control.

Summary: Water shut off sprinklers.

Water shut off system	2
Light water pressure	1
Floor openings	1
Total	4

9. DETAILS OF LARGE LOSS FIRES. (Where sprinkler control was satisfactory.)

202. November 1, 1898. Montreal, Quebec. Fire started on third floor under some shelves and was held in check by one sprinkler. It burned through floor into concealed space, ceiling below being sheathed. Fire spread in this concealed space and in all twenty-nine sprinklers opened. There was no watchman, the only alarm system being electric attachment to the dry valve this being connected with central station system. The alarm company only received one round as the attachment was corroded and did not maintain the contact. They sent a man to find out what was the trouble, but on seeing no indications of fire he telephoned the assured before sending in alarm. This made a serious delay before sprinklers were shut off and there was a heavy water damage. Loss about $6,000.

Summary: Defective alarm service.

591. July 28, 1899. New York, N. Y. Serious damage in stock of silk neckwear. Two sprinklers practically controlled the fire. Pails of water were also used. Loss about $7,500.

Summary: Susceptible stock.

594. August 4, 1899. Syracuse, N. Y. Fire occurred on top floor of mill constructed building. Two sprinklers operated and extinguished the fire. Fire occurred at night and there was no watchman. It is stated that sprinkler alarm bell rang and that a passerby heard it and notified the fire department. Apparently a very serious delay in discovering the fire owing to the defective alarm service and lack of watchman. Loss on contents approximately $30,000.

Summary: Defective alarm service.

743½. February 20, 1900. Buffalo, N. Y. Fire occurred on seventh floor and was practically extinguished by two sprinklers. There appears to have been no serious delay in discovering the fire. Water supplies to equipment were tank and pump. It seems that the

pump was operated and the check valve at tank stuck open, the tank overflowing and flooding the building. Loss about $20,000.

Summary: Defective check valve at tank.

1375. April 1, 1901. Atlanta, Ga. One sprinkler practically extinguished the fire. Sprinkler alarm operated and called the fire department, watchman also heard the sprinkler alarm. There is a gate valve controlling each floor, but watchman not being familiar with the system went to basement and shut off city water, but failed to shut off tank valve which was close to the city valve so that sprinklers continued operating with tank supply. Engineer of plant had to be sent for before the gate valve was finally closed. Loss about $23,000.

Summary: Neither watchman or fire department knew how to shut off water.

1891. June 19, 1902. New York, N. Y. Fire occurred on fifth floor occupied by manufacturers of shirt waists. Originated from some unknown cause under two cutting-tables covering the space of about 9′x18′. These interfered with the distribution of the water so that sufficient heat generated to open forty sprinklers. Sprinklers held fire in check although gravity tank was soon drained. Fire department completed the work. Loss about $42,000.

Summary: Obstruction to distribution.

2374. April 8, 1903. Chicago, Ill. Fire occurred on fourth floor of brick building, mill construction. The only alarm service was an angle alarm connected to local bells; no watchman. Fire occurred sometime in the night and was not discovered until engineer arrived in the morning and saw water coming through basement ceiling. Only one sprinkler opened, but it ran for sufficient time to discharge about 10,000 gallons from pressure and gravity tanks. Loss $40,000.

Summary: Lack of alarm service.

3369. November 28, 1904. Toronto, Ont. Fire occurred on third floor under counter among waste paper. Ordinary open joist construction. Five sprinklers practically extinguished fire. Alarm was given promptly to central station by the thermostats and the fire department were telephoned. Employee on fourth floor also notified fire department promptly. The firemen used a chemical and completed the work of the sprinklers in a very short time. They then looked for the controlling valve, there being one on that floor, but they were unable to find it. They then shut off two other valves controlling other sections on the same floor. This state of affairs existed until the engineer arrived about an hour afterwards and he had the proper valve turned off. It is said that the firemen opened the drip of the tank and allowed contents to run into sewer, they also shut the valve which controlled the outside systems. They did not close the city water controlling valve or the proper controlling valve on the floor where the fire occurred. Loss about $26,000.

Summary: Lack of knowledge as to location of shut-off valve.

10. POINTS OF INTEREST FROM SPRINKLERED FIRE REPORTS.

Concealed Spaces.

202. Sheathed ceiling second floor, fire got in the concealed space.

849. Sprinklers could not extinguish fire in joist channels back of plastered ceilings.

Gate Valves.

2776. The cut-off valve is on top floor under tank, with door to loft locked, so engineer opened drip to stop flow of water from sprinklers and thereby emptied tank. A few gallons of water extinguished fire.

3369. Heavy water damage due to delay in locating shut-off valve by the firemen.

Obstruction to Distribution.

1724. Sprinklers held fire, but could not extinguish same as it was under cutting-table.

1891. Bins under tables, etc., should be equipped with sprinklers, as one head properly placed would have extinguished this fire.

4734. Water could not get at fire which started under large cutting-table.

4826. Obstruction to distribution considerable, from long pressing table four feet wide.

Open Sprinklers.

299. The Walworth open sprinklers were used to good effect and with the help of fire department hose streams and buckets prevented fire from getting into building.

11. NUMBER OF SPRINKLERS OPENED.

No of Sprinklers Operating.	Extinguished. Fire. No. of fires.	Extinguished. Fire. Per cent.	Held Fire in Check. No. of fires.	Held Fire in Check. Per cent.	Unsatisfactory. No. of fires.	Total. No. of fires.	Total. Per cent.	No. of Sprinklers Operating.	Per cent. No. of fires.	Per cent. of whole
1	40	49	3	21	0	43	43	1	43	43
2	19	23	2	14	0	21	21	2 or less	64	64
3	4	5	0	0	0	4	4	3 or less	68	68
4	7	9	0	0	0	7	7	4 or less	75	75
5	2	2	1	7	0	3	3	5 or less	78	78
6 to 9 inc.	5	6	2	14	0	7	7	Less than 10	85	85
10 to 24 inc.	2	2	3	21	0	5	5	Less than 25	90	90
25 to 49 inc.	2	2	3	21	0	5	5	Less than 50	95	95
50 and over	1	1	0	0	4	5	5	50 and over	5	
Total	82		14		4	100				

Average number of sprinklers not including unsatisfactory, 5.0

12. ALARM SERVICE.

	Satisfactory.		Failure.		Total
	No. of Fires.	Per cent.	No. of Fires.	Per cent.	
Watchman	16	76	5	24	21
Thermostat	31	86	5	14	36
Sprinkler	65	91	6	9	71

Points of Interest from Fire Reports as Regards Alarm Service.

2374. The large water damage was largely due to absence of approved watch service and outside alarm connections.

2804. There was no thermostat within ten feet of point over fire and nearest did not operate.

3111. The sprinklers directly over fire operated and controlled same. The thermostats were twelve feet from the fire, and the heat was not sufficient to operate them. (Watkins closed cap.)

3244. Thermostats operated four minutes before sprinklers opened, so that water flowed but a short time before the patrol arrived and finding fire totally extinguished they shut gate valve on floor promptly, saving water damage.

3828. Combination gate check and alarm valve, connected to bell in boiler room, failed to operate.

The regular watchman was off duty the night of the fire and his place was taken by a man who has been employed by the owner of the building for over thirty-five years. This watchman did not punch the clock, but stated that everything seemed in good shape when he passed through.

4734. The failure of the central station to receive a water flowing alarm was not due to the alarm but to the failure of the transmitter

4784. No watchman on floor where fire started. Watchman on floor below discovered fire.

5614. In transmitting alarm to fire station, the central station use a telegraph alarm. They sent in signal by this last night, but operator at Fire Hall could not distinguish number. He called up the Holmes Station over private phone and they stated that they thought there was a fire at risk; reels sent them. Later the Holmes people telephoned that there was a fire at risk. It is stated that the delay caused through the gong not operating properly would not be more than a minute.

Central station states that they sent a man to test alarm gong later in the evening and found it in order. A test of the same was made this morning, at request of inspector, and while several signals came in promptly, it was impossible to distinguish some of them. Clockwork of gong ran down while being tested. Central station state that a test of this gong is made about once a week, but no records kept. Were unable to state date of last test. Would advise daily test of same in future, record to be kept. This telegraph connection is said to be tested daily, but no record kept of this.

13. SECONDARY WATER SUPPLIES.

5485. Primary supply of city water, second supply gravity tank, third supply steamer connection. The first two supplies were shut off at time of fire and steamer connection was used to advantage.

5679. Primary supply two pressure tanks, second supply city water. Fire on second floor opened forty-seven heads and city water was of service as a second supply, the pressure in pressure tanks being quickly reduced owing to the large number of heads opened.

14. EFFICIENCY OF WATER SUPPLIES.

Primary Water Supply.	Number of fires	Per cent. of fires	Average Pressure	Average number Spkrs. opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.	
					Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check
Water works,	20	20	76	4.3	90	5	5	75	100	55	4.2	6.0
Gravity tank,	46	46	21	5.4	76	20	4	23	16	14	2.8	15.4
Pressure tank,	32	32	91	5.4	87	13	0	90	96	0	5.3	6.2
Automatic pump,	1	1	50	6.0	100	0	0	50	0	0	6.0	.0
Total,	99		55	5.0	82	14	3	58	45	27	4.0	12.1

15. EFFICIENCY OF WATER PRESSURES.

Pressure on Sprinklers.	Number of fires	Per cent of fires	Average Pressure	Average number Spkrs. opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.	
					Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check
Less than 15 lbs.,	11	11	10	6.4	64	27	9	10	11	10	2.8	14.6
15 to 24 lbs. inclusive,	17	17	18	7.3	70	24	6	19	15	17	2.1	23.0
25 to 49 lbs. inclusive,	20	20	31	3.0	90	10	0	32	27	0	3.2	1.5
50 lbs. and over,	51	51	86	5.1	88	10	2	86	97	55	5.0	6.2
Total,	99		55	5.0	82	14	3	58	45	27	4.0	12.1

16. EFFICIENCY OF WET OR DRY SYSTEM.

Wet or Dry System.	Number of fires	Per cent. of fires	Average Pressure	Average number Spkrs. opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.	
					Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check	Unsatisfactory	Extinguished fire (or practically extinguished)	Held fire in check
Wet system,	83	83	53	4.6	81	17	2	45	45	13	3.0	12.1
Dry system,	16	16	66	8.3	94	0	6	67	0	55	8.3	
Total,	99		55	5.0	82	14	3	58	45	27	4.0	12.1

Note—"Average number of sprinklers opened" does not in any case include the Unsatisfactory fires.

17. EFFICIENCY OF WATER SUPPLIES. As Regards Amount of Loss.

Primary Water Supply.	Number of fires	Per cent. of fires	Average Pressure	Av. No. Spkrs. opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.		
					No claim	Small loss	Large loss	No claim	Small loss	Large loss	No claim	Small loss	Large loss
Water works,	20	20	76	4.3	25	50	25	53	79	70	1.4	3.8	9.2
Gravity tank,	46	46	21	5.4	22	67	11	25	21	15	2.4	5.1	18.0
Pressure tank,	32	32	91	5.4	38	59	3	92	89	105	1.3	8.3	1.0
Automatic pump,	1	1	50	6.0	0	0	100	0	0	50	.0	.0	6.0
Total,	99		55	5.0	27	60	12	64	52	48	1.7	5.9	10.9

18. EFFICIENCY OF WATER PRESSURES. As Regards Amount of Loss.

Pressure on Sprinklers.	Number of fires	Per cent. of fires	Average Pressure	Av. No. Spkrs. opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.		
					No claim	Small loss	Large loss	No claim	Small loss	Large loss	No claim	Small loss	Large loss
Less than 15 lbs.,	11	11	10	6.4	10	72	18	10	11	10	5.0	8.1	2.0
15 to 24 lbs, inclusive,	17	17	18	7.3	18	64	18	15	19	16	1.6	5.5	26.0
25 to 49 lbs. inclusive,	20	20	31	3.0	35	65	0	31	31	0	2.3	3.5	.0
50 lbs. and over,	51	51	86	5.1	31	55	14	91	87	72	1.3	6.8	7.3
Total,	99		55	5.0	27	60	12	64	52	48	1.7	5.9	10 9

19. EFFICIENCY OF WET OR DRY SYSTEM. As Regards Amount of Loss.

Wet or Dry System.	Number of fires	Per cent. of fires	Average Pressure	Av. No. Spkrs. opened	Per Cent. of Fires.			Average Pressure.			Average Number Sprinklers Opened.		
					No claim	Small loss	Large loss	No claim	Small loss	Large loss	No claim	Small loss	Large loss
Wet system,	83	83	53	4.6	27	63	11	63	55	45	1.6	5.2	9.0
Dry system,	16	16	66	8.3	31	50	19	66	70	57	2.0	10.0	17.5
Total,	99		55	5.0	27	60	12	64	52	48	1.7	5.9	10.9

Note—"Average number of sprinklers opened" does not in any case include the Unsatisfactory fires.

Flour Mills and Grain Elevators--- Fire Record.

The Millers National Insurance Company recently published a pamphlet on Causes of Fires in Flour Mills and Grain Elevators. This data has been tabulated along the same lines as the Fire Record Classifications of the Special Hazard Committee and is printed here as covering a considerable number of fires over a ten-year period.

FLOUR MILLS.

Total Number of Fires, 482.

Common Causes.

		No. of Fires.	Per cent. of Whole.
LIGHTING. Number of fires		11	5.0
Electric wiring	7		
Break in gas-pipe	1		
Explosion of lantern	2		
Lamp upset	1		
HEATING. Number of fires		5	2.3
Steam-pipe	1		
Overheated stoves	4		
POWER. Number of fires		29	13.2
Hot boxes and friction	23		
Friction at belt	4		
Electric motor	1		
Water-wheel	1		
BOILER (or Fuel). Number of fires		32	14.6
Sparks from stack	10		
Defective chimneys	6		
Overheated stack or breeching	7		
Defective boiler setting	4		
Natural gas fuel	3		
Spark in wood-pile	1		
Ignition of straw for fuel	1		
RUBBISH. Number of fires		0	
OILY MATERIAL. Number of fires		1	0.5
Oily waste ignited	1		
SMOKING. Number of fires		0	
LIGHTNING. Number of fires		38	17.3
SPARKS FROM LOCOMOTIVES. Num- of fires		10	4.5

		No. of Fires.	Per cent. of Whole.
MISCELLANEOUS. Number of fires		5	2.3
Tinners fire pot	2		
Sparks from Roman candle	1		
Careless use of matches	1		
Slaking lime	1		
Total		131	

Special Hazards.

SPONTANEOUS COMBUSTION. Number of fires	24	10.9
CONVEYORS. Number of fires	16	7.3
CLEANERS AND BRUSH MACHINES. Number of fires	24	10.9
BOLTERS. Number of fires	5	2.3
SEPARATORS. Number of fires	5	2.3
CORN SHELLERS. Number of fires	3	1.4
GRINDING. Number of fires	7	3.2
DUST EXPLOSIONS. Number of fires	3	1.4
MEAL DRYERS. Number of fires	1	0.5
Total	88	
COMMON CAUSES	131	60
SPECIAL HAZARDS	88	40
Total	219	
INCENDIARY	19	
EXPOSURE	34	
UNKNOWN	210	
Total number of fires	482	

GRAIN ELEVATORS.

Total Number of Fires, 350.

Common Causes.

LIGHTING. Number of fires		1	0.6
Defective electric wiring	1		
HEATING. Number of fires		12	7.3
Overheated stove	12		
POWER. Number of fires		18	11.0
Hot box or friction	16		
Gas engine exhaust	2		

		No. of Fires.	Per cent. of Whole.
BOILER (or Fuel). Number of fires		15	9.2
Overheated stack	7		
Sparks from stack	5		
Defective chimney	1		
Defective boiler setting	1		
Hot cinders	1		
RUBBISH. Number of fires		0	
OILY MATERIAL. Number of fires		0	
SMOKING. Number of fires		2	1.2
LIGHTNING. Number of fires		72	44.2
SPARKS FROM LOCOMOTIVES. Number of fires		21	12.9
MISCELLANEOUS. Number of fires		7	4.3
Gasolene	4		
Tramps	2		
Tinners fire pot	1		
Total		148	

Special Hazards.

CONVEYORS (Elevator head and boot) Number of fires		7	4.3
SPONTANEOUS COMBUSTION. Number of fires		4	2.5
DUST EXPLOSIONS. Number of fires		1	0.6
CORN CLEANER. Number of fires		1	0.6
GRAIN DRYER. Number of fires		1	0.6
SPARKS FROM COB PIT. Number of fires		1	0.6
Total		15	
COMMON CAUSES		148	91
SPECIAL HAZARDS		15	9
Total		163	
INCENDIARY		17	
EXPOSURE		33	
UNKNOWN		137	
Total number of fires		350	

Sprinkler Fire Record.

UNSATISFACTORY OR SERIOUS FIRES IN RISKS EQUIPPED WITH SPRINKLERS.

5806. Alton, Ill. March 4, 1906. Glass Bottle Works. The fire occurred in metal clad frame joist constructed furnace and lehr building. Fireman noticed fire under the floor along side of furnace. Risk was equipped with old style Neracher and Grinnell heads on dry system; Neracher dry valve, supplied by water works ninety pounds pressure and steam pump. Sprinklers did not control the fire and this building was destroyed. No reason has been assigned for the failure of the sprinklers to hold the fire in check and as the fire occurred over a year ago we are unable to obtain definite information.

Summary: Cause not known.

5246. Cleveland, Ohio. February 28, 1907. Picture Frame Factory. Brick building of light joist construction with wood sheathing. Lumber dry kilns on first floor not cut off, heated by hot air. Fire occurred at point near the blower, probably due to the use of an open torch. Fire spread rapidly through the wood ducts to the dry kilns. Alarm seems to have been given promptly and engineer states that when the fire department arrived some one ordered him to shut off the sprinkler system which he did, but twenty minutes later system was turned on again and fire was finally brought under control. This was in the afternoon and shortly after midnight a second fire broke out with the sprinkler system shut off and out of commission. About half of the plant was destroyed.

Summary: Water shut off sprinklers.

5640. Hampton, N. H. March 1, 1907. Electric Car House, (continued, see April, 1907, Quarterly Bulletin). The Grinnell dry valve in this risk has been tested since the fire but nothing positive developed which would seem to have rendered it inoperative or to have seriously impeded the flow of water. It is probable however that the dry system combined with the light pressure from tank accounts for the failure of the sprinklers to hold the fire in check. The only water supply to sprinklers was a 9,000 gallon gravity tank and one-half of the water could be used for domestic purposes. Pressure on sprinklers in stock room where fire occurred was about eighteen pounds.

Summary: Deficient water supply.

5812. Marlborough, Conn. March 1, 1907. Silk Weaving Mill. Fire occurred on second floor, probably caused by hot bearing. Risk equipped with an old style defective system, unapproved Kane sprinklers supplied by pond on level with top of building and a small rotary pump. Pump was not started and as the sprinklers had little or no pressure they had no effect on the fire. Risk burned.

Summary: Defective equipment.

5831. Bridgeport, Conn. March 13, 1907. Planing Mill. Fire occurred in lumber dry room over boiler, open joist construction with slatted floors, and was probably caused by spark from boiler. The building was equipped with Grinnell Issue "D" sprinklers, mostly high test,

small pipe sizes, considerable obstruction to distribution from the lumber. Dry system with sixty pounds air pressure at time of fire. System supplied by water-works and gravity tank, the former giving thirty-five pounds on sprinklers that operated. Sprinklers appear to have been of little or no value probably owing to somewhat defective equipment, high test heads and slow action of dry system.

Summary: Generally defective equipment.

5845. Brighton, Vt. March 15, 1907. Furniture Factory. Fire occurred in sawdust vault, boiler and engine room. Brick building of joist construction equipped with Manufacturers sprinklers, wet system, supplied by gravity tank giving from fifteen to twenty pounds pressure. Sprinklers were of little or no value and it appears that either the tank was emptied or the system was frozen up, probably the latter. This system had had no care for some time and was found frozen up at an inspection a few weeks before the fire.

Summary: System probably frozen.

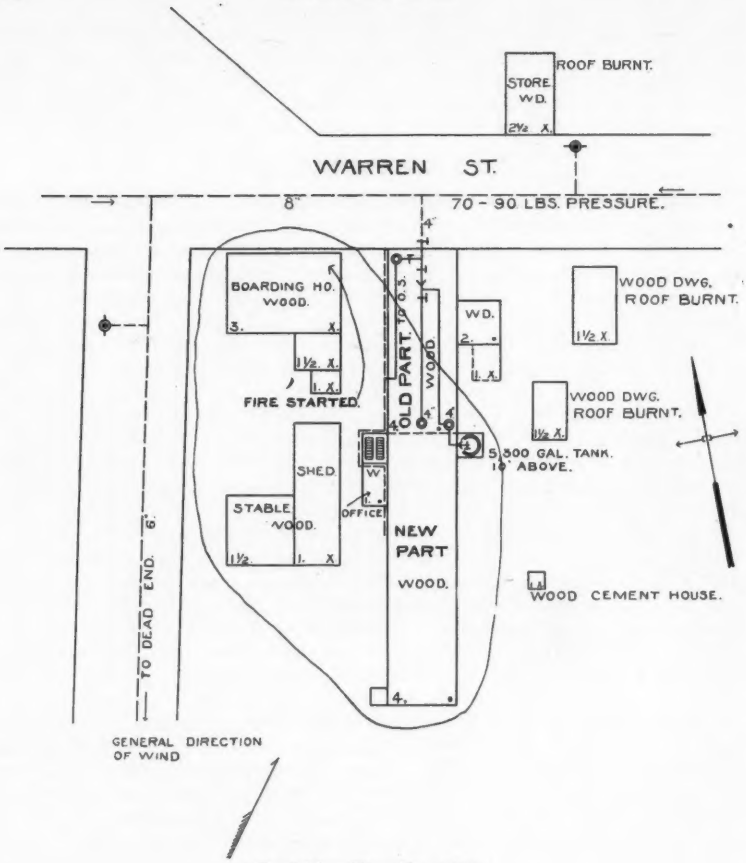
5856. Randolph, Mass. March 22, 1907. Shoe Factory. Fire started in third story of frame boarding house and store about twenty feet from frame sprinkled shoe factory. The outside protection is poor and the exposure got beyond the control of the fire department and attacked shoe factory, burning off the two upper floors. Risk was equipped with Grinnell glass disc sprinklers old standard spacing and pipe sizes, wet system supplied by water-works fifty to seventy pounds pressure and gravity tank. Hose streams reduced the street pressure and owing to the large number of sprinklers which were opened the system was overtaxed. Building has a wood box cornice and under the cornice were Grinnell shovel pattern open sprinklers. No one thought of these sprinklers and they were not used.

Summary: Exposure fire.

5860. Pine Bluff, Ark. March 22, 1907. Planing Mill. One story with shafting under flooring. Risk equipped with Grinnell wet system supplied by 25,000 gallon gravity tank elevated fifty-five feet. Fire occurred at hot box on main line shaft under floor. There were no sprinklers under the floor and fire gained headway so that before sprinklers could become affected fire was beyond control.

Summary: Unsprinkled basement.

5861. Cincinnati, Ohio. March 25, 1907. Sheet Metal Worker. Building destroyed is a three-story and basement, brick joist construction, occupied for storage of tin and granite ware with some packing material. Stock was piled in slatted bins running to ceiling badly obstructing sprinklers. Risk was equipped with Grinnell Issue "A" sprinklers, dry pipe system, spacing ten feet across joists, staggered nine feet across lines, supplied by a 10,000 gallon gravity tank giving from fifteen to twenty pounds on second floor where fire started. System also connected with city water. This was of no value. Fire doors to adjoining building were of good service. Fire started in a quantity of packing material and was soon beyond control. Later on sprinklers were shut off this section by means of indicator valve in yard so that sprinklers in adjoining section were kept in service. The failure of the sprinkler equipment to control the fire was probably due to obstruction to distribution combined with a somewhat defective equipment. The value of a fire engine connection to sprinkler equipment was



Sprinkler Fire No. 5856.

thoroughly demonstrated by the efficient manner in which the fire was extinguished in the west section by the sprinklers after connection was made, and it is probable that if the first engine arriving at the fire had made use of the above steamer connection the fire would have been controlled with moderate loss.

Summary: Obstruction to distribution.

5864. Philadelphia, Pa. March 27, 1907. Cotton Spinning Mill. Fire occurred on second floor in first break of cards, open mill construction. Fire spread rapidly and opened up about forty-five sprinklers which controlled the fire satisfactorily. Sprinklers were shut off and shortly after engineer and machinist started replacing sprinklers on the second floor. While doing this fire started up again in a bundle of yarn and spread quickly over piles of yarn and bales of cotton. Sprinkler valve was

opened up as quickly as possible and probably only a few minutes elapsed but this was sufficient to allow fire to gain headway. Fire spread through small belt hole into third story and altogether some seventy heads opened on the second floor and forty-eight on the third. Fire also burned through roof at one end. It was finally controlled by sprinklers and hose streams

Summary: Water shut off.

5881. Syracuse, N. Y. March 28, 1907. Sash, Door and Blind Factory. Fire started in lumber dry kiln over shaving vault, joist construction, brick walls. Risk equipped with Manufacturers old style pendent heads on dry system but wet at time of fire, supplied by city water ninety pounds pressure. About 10 to 12% of the sprinklers failed to open properly as the valve stuck to the seat. Obstruction to distribution and a large amount of inflammable material aided the spread of fire.

Summary: Defective equipment.

5883. Chicago, Ill. April 4, 1907. Furniture Factory. Fire occurred on top floor of brick building of ordinary brick construction occupied for storage and varnish dipping. Fire occurred at dip tank and communicated with roof joists. Risk equipped with Grinnell metal disc sprinklers, old style equipment, wet system, the only supply being a 2,600 gallon gravity tank. Tank was soon exhausted and sprinklers of little service. There was a steamer connection but fire department did not use it. Some of the sprinklers fused but failed to open, probably due to sticking at the seat.

Summary: Generally defective equipment.

5913. Lockhart, S. C. April 11, 1907. Cotton Mill. Fire occurred in picker room from some unknown cause, and spread rapidly through cotton. Sprinkler system was shut off at time of fire probably due to misunderstanding of system and valves. The important water supply was located at a neighboring mill and the valve in connection pipe between the two mills was closed, also small tank at mill where fire started was shut off. After valves were opened the sprinklers did good work and fire was finally controlled.

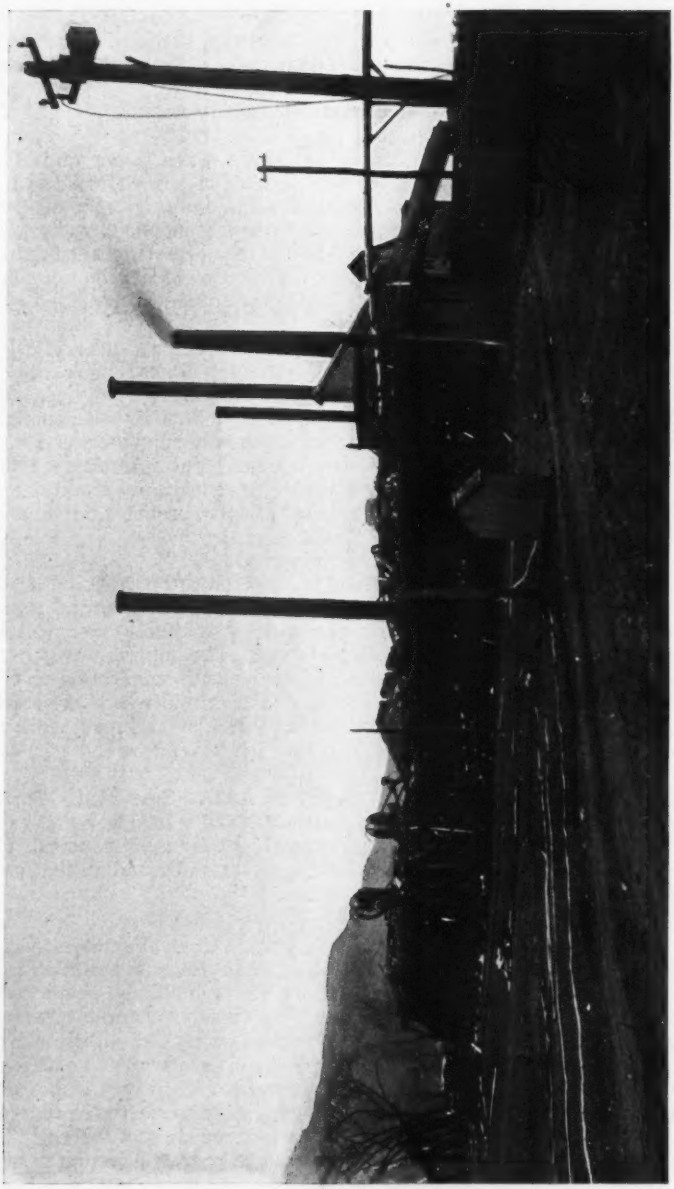
Summary: Water shut off.

5919. Northampton, Mass. April 27, 1907. Saw Mill. Sprinkler equipment was entirely out of commission at time of fire owing to the fact that it was being overhauled and brought up to present standard. Fire occurred at or near refuse conveyor and spread rapidly and all that could be done was to save surrounding properties.

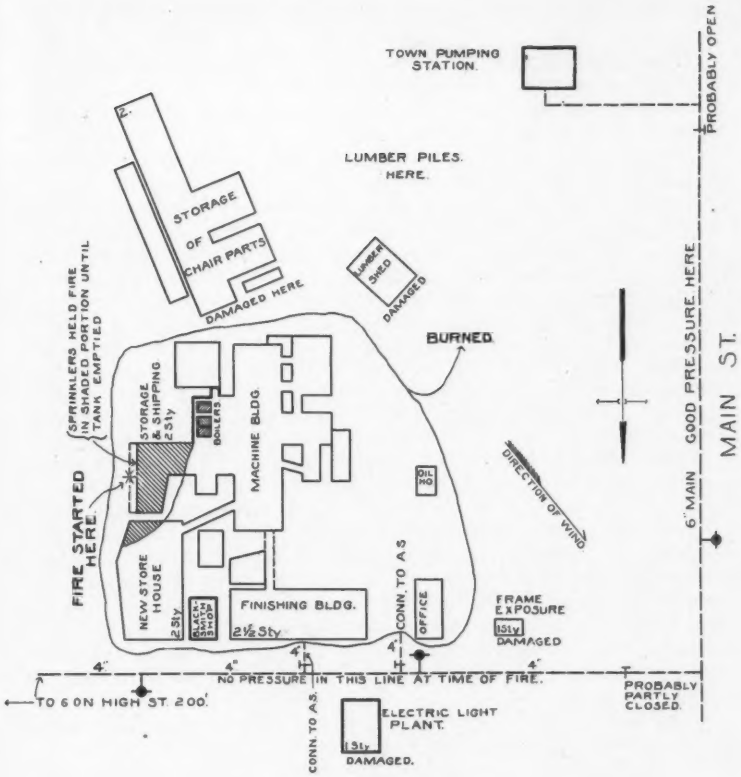
Summary: Water shut off.

5934. Union City, Pa. April 29, 1907. Chair Factory. Frame joist construction. Fire occurred in pile of chair parts and rubbish in an unsprinkled space under a small two-story frame building occupied as a shipping room and storehouse. Fire spread rapidly over the outside of the building. Building where fire occurred was equipped with Rockwood dry system and Clayton dry valve supplied by water-works and gravity tank. The street supply was a four-inch main and proved to be of no value, probably due to small size and sediment also partly closed gate. Gravity tank was soon empty owing to the large number of sprinklers opened. Sprinklers and dry valve said to have operated promptly.

Summary: Unsprinkled portions.



Sprinkler Fire No. 5919.



Sprinkler Fire No. 5934.

5935. New Hampshire, May 11, 1907. Cotton Mill. Fire occurred in card room. Sprinklers were shut off at time of fire as the system was being overhauled and improved. Fire was finally controlled by hose streams.

Summary: Sprinklers shut off.

5936. Orange, Conn. May 22, 1907. Rendering Works. Fire occurred in top floor of frame building, joist construction, occupied for grinding bone for fertilizer. Equipped with Grinnell glass disc sprinklers, Grinnell dry valve supplied by automatic steam pump and 10,000 gallon gravity tank. Sprinklers failed to control fire and roof burned off. After the fire it was found that one of the hand plugs on dry valve was off. It apparently was screwed in about three turns and had blown out. This took most of the pressure from the sprinklers. Fire was finally controlled with hose streams.

Summary: Defective dry valve.

OTHER SPRINKLER FIRES OF ESPECIAL INTEREST.

5884. Syracuse, N. Y. March 15, 1907. Agricultural Implements Factory. Fire occurred at paint dip tank for castings while it was in use. Tin-lined tank containing about one hundred and twelve gallons of half asphaltum and half naphtha. Naphtha ignited from spark or some other cause, making a quick hot fire. Risk was equipped with Manufacturers and Grinnell sprinklers, dry system supplied by waterworks eight-inch main, ninety pounds pressure. Forty-two sprinklers opened on the second floor and seven on the first floor and controlled the fire. Dip tank overflowed and carried the burning oil over the floor and through cracks to ceiling below. Hand chemicals appear to have been an important factor in finally extinguishing the fire. A severe dip tank fire controlled by sprinklers. No obstruction to distribution, comparatively little inflammable storage and abundant water supplies.

5940. New York, N. Y. March 15, 1907. Tenant Manufacturing. Risk equipped with New York and New Haven No. 1 elbow sprinklers. One head opened but owing to the very poor distribution it had little effect on the fire which was extinguished with water pails.

3955. March 21, 1907. Cement Mixing. The frame building marked "Storehouse No. 2" on the current insurance plan is used as a cement mixing house. At the time of the fire there was in this building six or seven metal drums holding about one barrel each of naphtha, seventeen iron barrels more or less full of rubber cement, with several small iron tanks used for mixing cement, and a metal lined tank about 4′x6′x18″ deep used for the same purpose and nearly full at the time of the fire. There was a barrel of kerosene and several other barrels of miscellaneous supplies used in the business. The iron cement cans and the mixing tanks were provided with covers and were nearly all covered at the time of the fire.

The building was sprinkled with a Grinnell sprinkler equipment on the wet system, fed from the system in the upper story of Storehouse No. 1 (the basement of which is unsprinkled), which system is supplied from the sprinkler system in No. 3 Mill.

Shortly after starting up on the morning of the fire, a boy in the cement mixing room was engaged in cutting off sheet rubber from a roll, pieces of which he was placing in an iron can of rubber cement mixture. There were other men working in the room at the time and it is thought that the fire must have started by a spark of frictional electricity, generated in pulling rubber from roll. There was no artificial light in use at the time of the fire.

Eight sprinklers opened and five hose streams, two by the mill and three by the public department, were used. The force at hand very promptly began the work of removal of the packages of cement and naphtha from the building and were enabled to do this as most of the material was in covered packages. Some naphtha and rubber cement, however, was spilled and washed out from the room burning on top of the water. The ground slopes very rapidly to the west of these frame buildings and some of the burning material was washed down into the basement of the northerly section of Storehouse No. 1 where the woodwork was slightly scorched, but this fire was taken care of by the men at hand

before it did any damage. The housing with which the stairs from the first story to the basement were provided was of advantage in preventing the spread of the fire to the upper floor. Very little damage by fire was done to the Storehouse No. 2, the only part of the building that was even scorched being directly over the can in which the fire started.

It seems remarkable that more damage was not done, considering the nature of the occupancy of this building, and credit seems due to the manner in which the fire was handled and to the automatic sprinklers with which the room was equipped.

5939. Savannah, Ga. March 28, 1907. Cotton Seed Oil Mill. Fire occurred on third floor of oil refinery and filter house on roof of refinery. Brick mill construction. Probably started at electric motor. Eighty sprinklers opened and held fire in check. Sprinklers supplied by automatic steam pump and gravity tank. An oil refinery fire of considerable magnitude held in check by sprinklers.

Miscellaneous Fire Record.

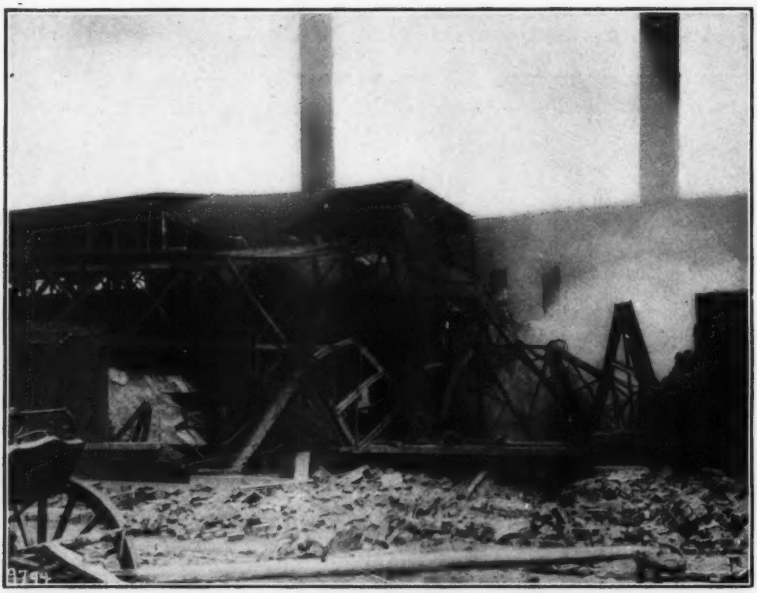
5937. New York, N. Y. April 8, 1907. Electric Car House. See diagram for construction and arrangement. Fire started on first floor, probably in the pit, from defective wiring or oily waste. It spread rapidly and was soon beyond control. Loss said to be in the neighborhood of one and a quarter millions, main four-story building being a total loss. Building collapsed early in the fire, due to the unprotected steel work. Fire doors between car house and power station held fire in check at that point.

Some of the conclusions made are as follows:

There was considerable delay in sending in the alarm and this appears to be true of most car house fires. Automatic alarm of some kind appears desirable.

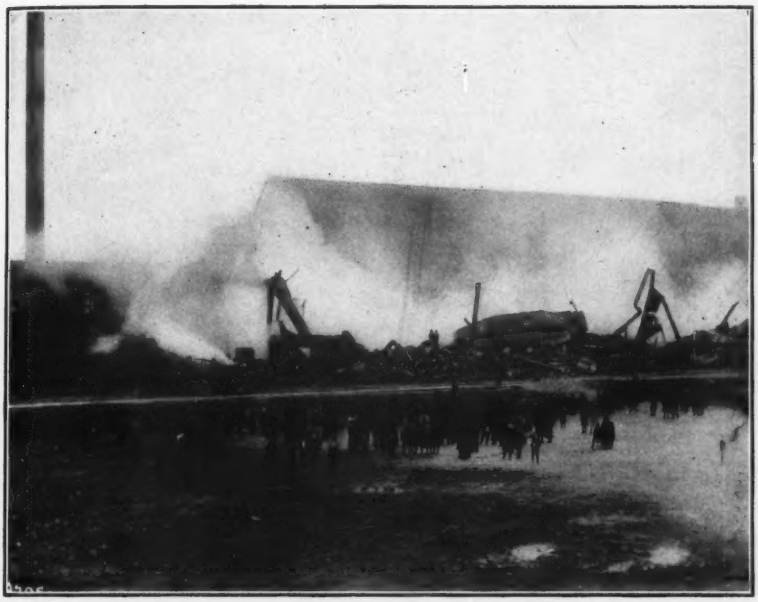
It is doubtful in a large car house like this whether there is any chance of extinguishing fire if it gets beyond one car.

1712. Boston, Mass. April 16, 1907. Wholesale Drug Storage. Fire occurred in barrel of celluloid scrap on second floor while the barrel was being scraped and hoops fixed. Workmen heard a peculiar puff and sizzling noise from inside the barrel and noticed smoke coming



Miscellaneous Fire No. 5937.

A Picture Taken at Close Range, Showing the Damage Done.



Miscellaneous Fire No. 5937.
The Site of the Fire in New York After the Walls Fell.

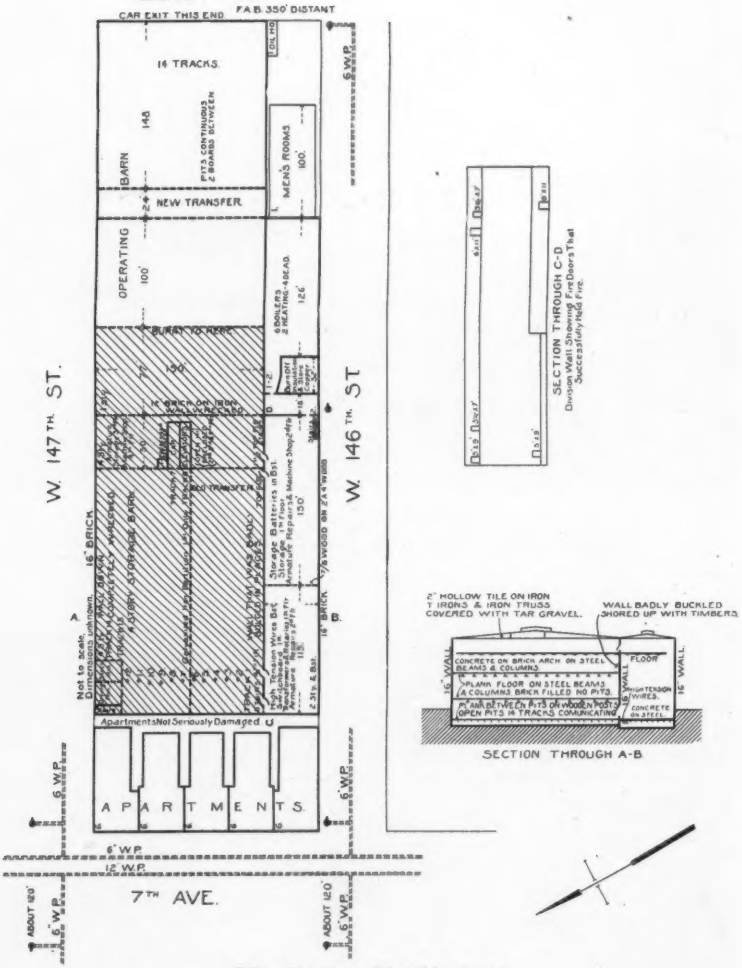
from the sides. Men started to get out of the way when explosion of moderate intensity occurred. One-half of the roof came tumbling into the street and the other half was lifted about one foot at the eaves while burning gases were forced out of windows and door openings in horizontal directions. The zone of combustion extended from one hundred and fifty to two hundred and fifty feet on both sides of the building. This did not last over fifteen seconds and then became an ordinary fire of considerable severity. There was in the building about six and one-half tons of celluloid scrap, mostly in barrels, and practically all of this was consumed. The cause of the fire as well as the intensity and severity is attributed to this celluloid scrap.

The following suggestions are made:

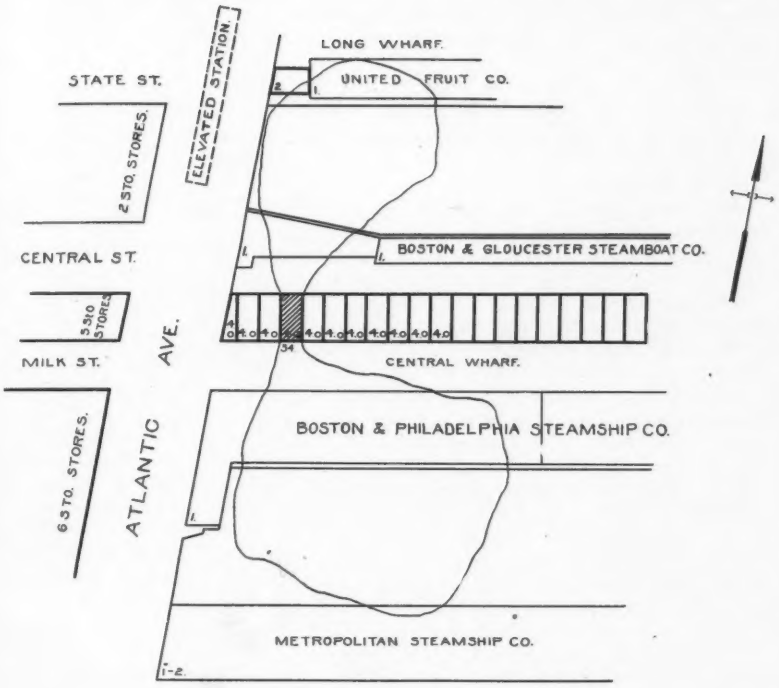
Not over three barrels of scrap celluloid (or two hundred and fifty pounds) should be allowed in buildings within the congested district of the city unless placed in fireproof vaults or different sections cut off by fire walls.

Buildings used for the storage of inflammable liquids should be ventilated every day.

5938. Providence, R. I. May 3, 1907. Paint Factory. Fire started in a one hundred and fifty-gallon hogshead mounted on trunnions, belted to shaft and used for cutting of shellac. Hogshead was filled with gum and denatured alcohol mixed in the following formula: one hundred



Miscellaneous Fire No. 5937.



Miscellaneous Fire No. 1712.

gallons grain alcohol; ten gallons wood alcohol; one-half gallon of benzine. Several days before the fire hogshead began to leak and extra hoops were provided tightened by bolts and nuts. About twenty-four hours before the fire occurred hogshead was emptied and two workmen were putting on these new hoops when an explosion occurred in the hogshead setting fire to the surrounding woodwork. It appears that a spark caused by one of the wrenches ignited gas inside of hogshead through the open bung.

5086. Philadelphia, Pa. May 24, 1907. Fertilizer Factory. This fire occurred in a new two-story building constructed of wood frame and corrugated iron. The building was located at a safe distance from the main glue factory, which has been in operation for some years.

The original business was glue manufacturing, the refuse being converted into fertilizers. Recently the fertilizing feature was extended, the building described was erected and fish scrap and king crabs were handled. The process comprises a boiling of the scraps in digesters to

remove all deleterious matter, the residue is then dried and reduced to carbon by passing it through a cylindrical drier heated to a high temperature from a furnace fire. The carbonized material is then ground and spread out and then packed in burlap bags. The product is carbon in a finely divided state and when exposed to the atmosphere will absorb oxygen sufficient to create heat to the point of ignition.

A number of instances were reported to this office where combustion occurred with a similar product from another factory during transportation in railroad cars and upon investigation at the factory from which the material was delivered a dangerous heating was observed in the material packed in bags ready for shipment. This heating was partly due to imperfect cooling of the material before packing and aided considerably in generating combustion.

This particular risk had previously experienced a fire from cause unknown. With the destruction in the recent case the positive cause is unknown, but the fire was first seen at a point where a large quantity of carbonized substance was stored.

5941. Barberton, Ohio. June 8, 1907. Rubber Reclaiming Plant. One and two-story building, wall 12″ and 14″ solid concrete also concrete division walls. Total area about 54′x115′. Adjoining and communicating at one end was a frame warehouse one-story, light board floors and roof. Fire started in the first story of the process building spreading from there through unprotected openings in the frame warehouse, back on the other side of the cut-off wall to the mill. Cause unknown at dryer. No protection and risk practically a total loss. Contractor who erected building advises that the concrete was one-third cement, two-thirds clear gravel. Report reads as follows regarding damage to concrete: North wall where fire seems to have been hottest is greatly damaged and will have to be torn down. Second and third stories very badly cracked and badly warped. First story also very badly cracked and scaled. West wall and division wall not materially damaged. East wall quite badly damaged. Third story south wall badly damaged and will have to be removed.

Notes and Tables.

AUTOGENOUS WELDING METHOD BY THE "EPURITE PROCESS."

As employed at the plant of the Worcester Pressed Steel Co., Worcester, Mass.

This is a method of welding or burning steel together by fusion without the use of any other metal, except that for certain joints a piece of steel wire is fused as needed. The process is quite similar to the oxyhydrogen flame, except that acetylene gas and oxygen are employed instead of oxygen and hydrogen. By the use of acetylene the products of combustion are carbonic acid gas and aqueous vapor, while by the oxyhydrogen flame the only product is the aqueous vapor or steam. It is quite possible that the carbonic acid gas formed by the combustion of the flame protects the fused surface of the metal from oxidation and tends to the production of a better joint or weld than could be produced by the oxyhydrogen flame.

An ordinary oxyhydrogen hand blowpipe is used, connected by rubber tubing to the pipes supplying the two gases which are kept separate until they combine in the flame at the tip of the blowpipe.

As far as the hazard of the process of actual welding is concerned it is no more hazardous than is the process of lead burning as practiced at all sulphuric acid works, except that the flame is larger, the size of flame varying with the size of the joint being made, the size of flame depending upon the pressure of oxygen employed and this pressure being governed by a small reducing pressure valve for each blowpipe, the pressure varying from five pounds per square inch for small work to twenty pounds or more for large work.

The process is said to have been in use in France for about two years, and has been introduced into this country by the Fore River Ship & Engine Co., Quincy, Mass., who use it in their works, and who manufacture this set of apparatus which is said to be the first one put out by them.

The name "Epurite" refers to a material in powder or granular form, which is a secret material from which the oxygen gas is produced by introducing it into water in a tank in a similar manner to the production of acetylene by calcium carbide and water.

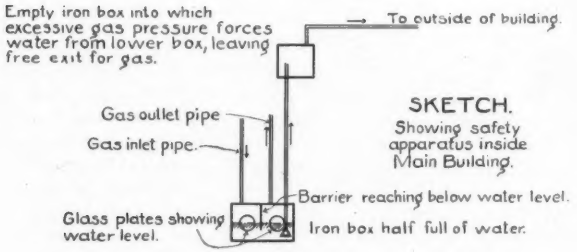
This powdered material not being as yet ready for delivery, the three materials composing it were sent to this plant and are mixed by the assured.

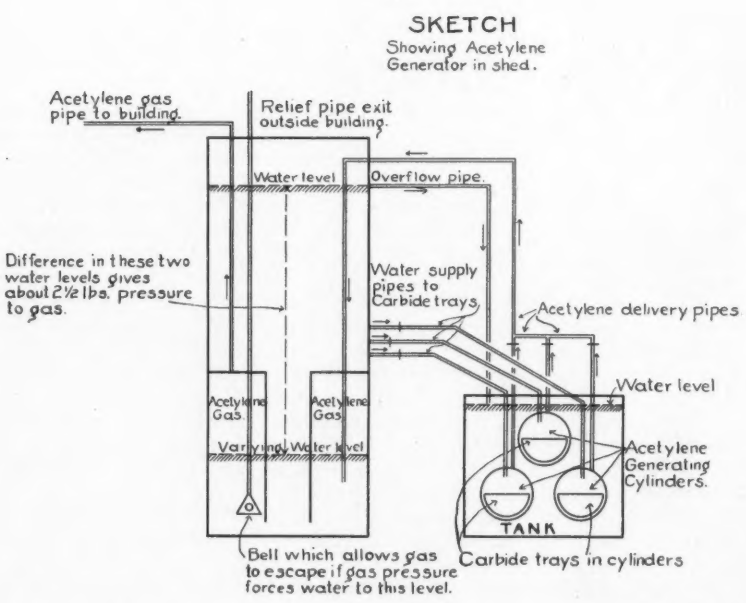
From an inspection of the materials it is evident that the material employed possesses no special hazards and is not combustible, nor is it capable of spontaneous combustion.

These substances in combination with water evolve oxygen by a somewhat complicated reaction and possibly some chlorine, the latter under proper conditions being absorbed by the water in the washer or scrubber.

There does not appear to be any hazard attached to this method of generating oxygen. It is likely to corrode the iron generator and pipes

AUTOGENOUS WELDING METHOD.
BY THE
EPURITE PROCESS.


Empty iron box into which excessive gas pressure forces water from lower box, leaving free exit for gas.
To outside of building.
SKETCH.
Showing safety apparatus inside Main Building.
Gas outlet pipe
Gas inlet pipe.
Barrier reaching below water level.
Glass plates showing water level.
Iron box half full of water.


SKETCH
Showing Acetylene Generator in shed.
Acetylene gas pipe to building.
Relief pipe exit outside building.
Water level
Overflow pipe.
Difference in these two water levels gives about 2½ lbs. pressure to gas.
Water supply pipes to Carbide trays.
Acetylene delivery pipes
Water level
Acetylene Gas
Acetylene Gas
Varying Water level
Acetylene Generating Cylinders.
TANK
Bell which allows gas to escape if gas pressure forces water to this level.
Carbide trays in cylinders

and they may be short-lived, but these are located in a shed eighteen feet from building.

Time and experience only can determine whether the oxygen generated will contain enough chlorine to prove destructive to the oxygen piping within the building, though it is not probable that it will do so. The oxygen after leaving the scrubber passes into the Main Building at second floor and is received into an ordinary sheet steel gas holder having a

capacity of about sixty cubic feet. It is pumped from this gas holder by means of a water-jacketed gas compressor (lubricated with glycerine) into a steel pressure tank and stored here under a pressure of from one hundred to one hundred and fifty pounds per square inch. From this tank pipes lead to the benches and to the reducing pressure valves before mentioned. The charge is about fifty pounds of "Epurite" and evolves about thirty-five cubic feet of oxygen.

The acetylene is generated in same shed as the oxygen but separated from oxygen section by a board partition. The acetylene generator is of special form or type and is not automatic.

The generator proper consists of a rectangular tank open on top and nearly filled with water. Within this tank and entirely covered by the water are several (in this case three) cylindrical iron tanks each about eight or ten inches in diameter, in horizontal positions with one end of each projecting through side of the rectangular tank containing them, the joints, of course, being water-tight. The ends are fitted with covers which can be clamped on. A semi-cylindrical tray (which is removable) is within each cylinder, and each tray is divided into five sections by vertical partitions. This tray when charged contains about three pounds of calcium carbide in each compartment, or fifteen pounds in all. The water is introduced by means of a small pipe, there being a separate pipe for each cylinder and each provided with separate stop-cock. When water is admitted into cylinder it enters one compartment of tray and decomposes the carbide, forming acetylene. When this compartment is full the water overflows into the next, and so on until all five compartments have been filled and the fifteen pounds of carbide decomposed. This produces approximately seventy-five cubic feet of acetylene gas at atmospheric pressure. No more gas can be generated unless the stop-cock connected to another cylinder is opened by hand.

The acetylene passes from the generator to a vertical iron tank partially filled with water, the depth being sufficient to create a pressure of about two and one-half pounds per square inch upon the gas and from here it is piped into the building. This tank is so arranged that a greater pressure than two and one-half pounds displaces the water seal to the relief pipe which discharges outside the building.

Within the building, between the entrance pipe and the benches where the gas is used, is located a small iron box partially filled with water through which the gas passes. Its function is to act as a fire check in case of the flame striking back into the pipes, and also by means of a relief pipe from this box to the outside of building to relieve any excess pressure by breaking the water seal to this relief pipe.

From the facts as above noted it does not appear that this acetylene generator offers any serious hazard as arranged and located at this plant, although it is not on the approved list. As already stated, it is not automatic, the amount of gas evolved is limited, and it is necessary for a man to be present when it is produced. The generator is located eighteen feet from building and an apparently effective relief device is provided in the generating shed and in the building by means of which an excessive pressure is reduced and the gas discharged outside the building.

The compressing, storage and use of oxygen at the maximum

pressure here employed, one hundred and fifty pounds per square inch, does not apparently offer any greater hazards than would be present if the ordinary commercial steel cylinders of this gas (which are in frequent use) were employed.

For additional information see plan herewith.

M. T. JONES, *Inspector.*
The New England Bureau of United Inspection.

RECLAIMING SPENT PYRITES.

By-Product Plants in Connection With Sulphuric Acid Plants.

A new hazard about to be introduced in connection with Sulphuric Acid Manufacturing Plants.

It appears that the hazards of the process are almost identical with those in the rotary kiln process of cement plants which consist of fusing powdered limestone and shale into clinker by the use of a fire blast from a powdered coal under pneumatic pressure. A brief description of the process is about as follows:

Spent pyrites are fed to brick rotary kilns which are slightly inclined at one end and slowly revolve, pyrites being stored in a steel tank or storage bin and fed to kilns by gravity. Under the influence of the revolving motion of the rotary kiln and the slight inclination of one end, the product is finally discharged in the form of a clinker and from two and one-half to five per cent. of sulphur is driven off and conveyed to atmosphere through stack. The heat produced in these kilns is sufficient to fuse the iron contained in the spent pyrites and form into a clinker which is simply an oxide of iron.

These plants also have in addition, the usual coal drying and pulverizing hazard, the same as is found in connection with cement plants producing clinker cement.

F. E. MACKNIGHT, *Chief Inspector.*
The South-Eastern Tariff Association.

"BURNITOL" CUSPIDOR.

There is being introduced into many of the large manufacturing plants, what is called the "Burnitol Cuspidor," its use being advocated from a sanitary standpoint. In construction it is of a fairly heavy cardboard, waterproofed, and folded into a flat box eight inches square by two and one-half inches deep. The top has a downward slope toward the centre with an opening four inches square.

These boxes are generally partially filled with dry sawdust and are supposed to be gathered up and burned entire at stated intervals, probably once or twice a week. The idea is to have them freely distributed for the use of employees, but as they cost from three to four dollars per hundred, it follows they will not be burned daily. It would appear from a fire standpoint that they embody all the hazards of the familiar wooden box of sawdust, and their use should be as strictly prohibited.

This cuspidor itself is readily combustible.

E. F. CARDELL, *Inspector.*
Starkweather & Shepley, Providence, R. I.

ANTINONNIN.

"Antinonnin" consists of the potassium salt of ortho and para di nitro cresol C_6H_2 (CH_3) (NO_2) 2 O. K. The corresponding sodium salt is known as Victoria Yellow, which was formerly used as a dye. These salts of the isometric ortho and para nitro cresols resemble in most ordinary properties the corresponding potassium and sodium derivatives of picric acid (tri nitro phenol) which are employed in the preparation of explosives.

"Antinonnin" is a reddish orange compound and readily soluble in water to an orange colored solution. It is used as a disinfectant. This compound, like its aforesaid analogues, explodes violently on percussion, or when heated. When cold and moist it is comparatively safe. When heated to 209 C. it undergoes decomposition with explosive violence. The heat from a lighted match or cigarette is sufficient to explode it. The explosive property of "Antinonnin" is due to the presence in the compound of the di nitro group. Generally speaking, the more nitro groups in a molecule the greater the danger of explosion. As we would expect, "Antinonnin" is not as dangerous as most of the compounds containing the penta tetra and tri nitro groups, but is more explosive than those compounds containing the mono nitro groups. For instance, it is not as powerful as the potassium picrate (potassium tri nitro phenol), but it is exceedingly dangerous, and is therefore a very important risk.

"Antinonnin" is put up in sealed cans, but after these are once opened there appears to be no ready means of keeping it moist.

As regards the possibility of spontaneous decomposition resulting in explosion, it may be stated that generally if nitro compounds are chemically pure spontaneous ignition and explosion is hardly possible, but the presence of impurities in nitro products may result in decomposition and cause explosion. In the case of "Antinonnin" there appears to be no danger in this respect if it is kept moist, but in use it is evidently liable to become dry, and, moreover, when exposed may easily be contaminated with other substances which may decompose it.

"Antinonnin" is more dangerous in use, because its name gives no clue as to its dangerous property, nor is there any warning whatever printed on the containers. There is not even added a caution to keep moist. It, therefore, appears that "Antinonnin" as used is a serious hazard to life and property.

A. H. NUCKOLLS, *Chemical Engineer.*
The Underwriters' Laboratories, Inc.

May 16, 1907. St. Louis, Mo. BREWERY. An explosion occurred at 11.11 a. m., caused by the owner dropping a lighted cigar or match into a keg containing about five pounds of "Antinonnin." He was seriously injured and some damage was done to the building.

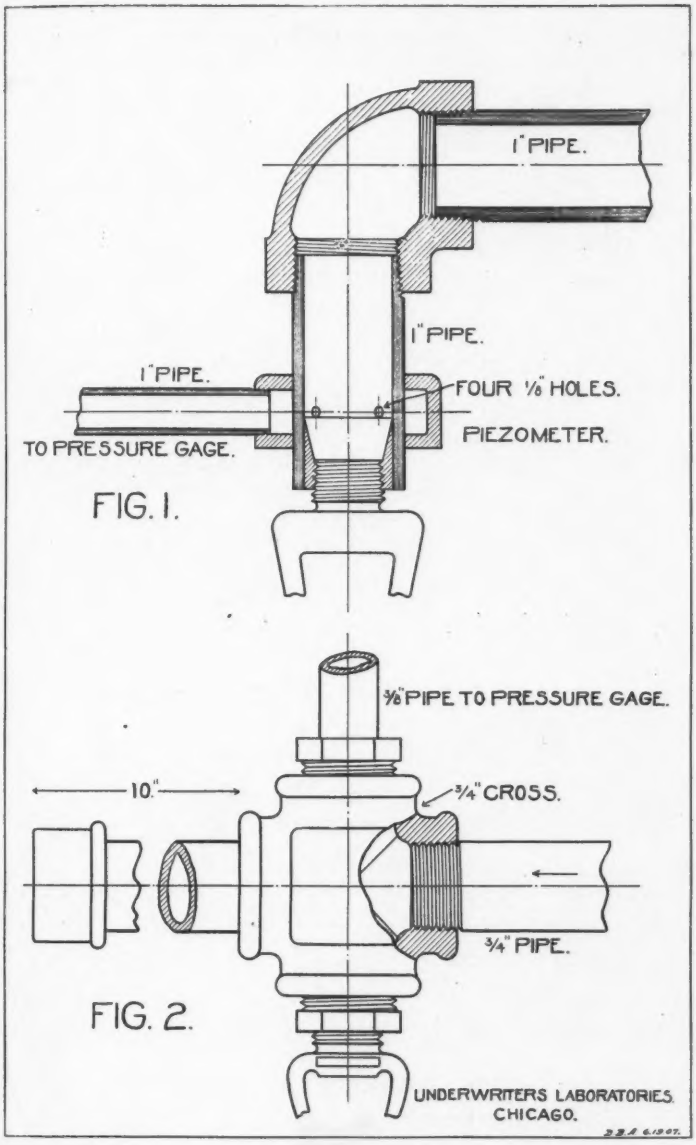
OPEN SPRINKLER DISCHARGE TESTS.

The following curve sheet shows the discharge of open sprinklers of varying orifices according to tests made by the Underwriters' Laboratories at Chicago. According to the rules and regulations of our Association three sizes of orifice may be used, namely, ⅜", 5/16" and ¼", and tests were made in these sizes. All sprinklers tested had an unobstructed smooth bore tapering outlet. Two methods of connecting the piping, sprinkler and pressure gauge were used, see Figures No. 1 and No. 2. In Figure No. 1 a piezometer connection is shown while in Figure No. 2 the pressure gauge is connected on the upper side of a ¾" cross.

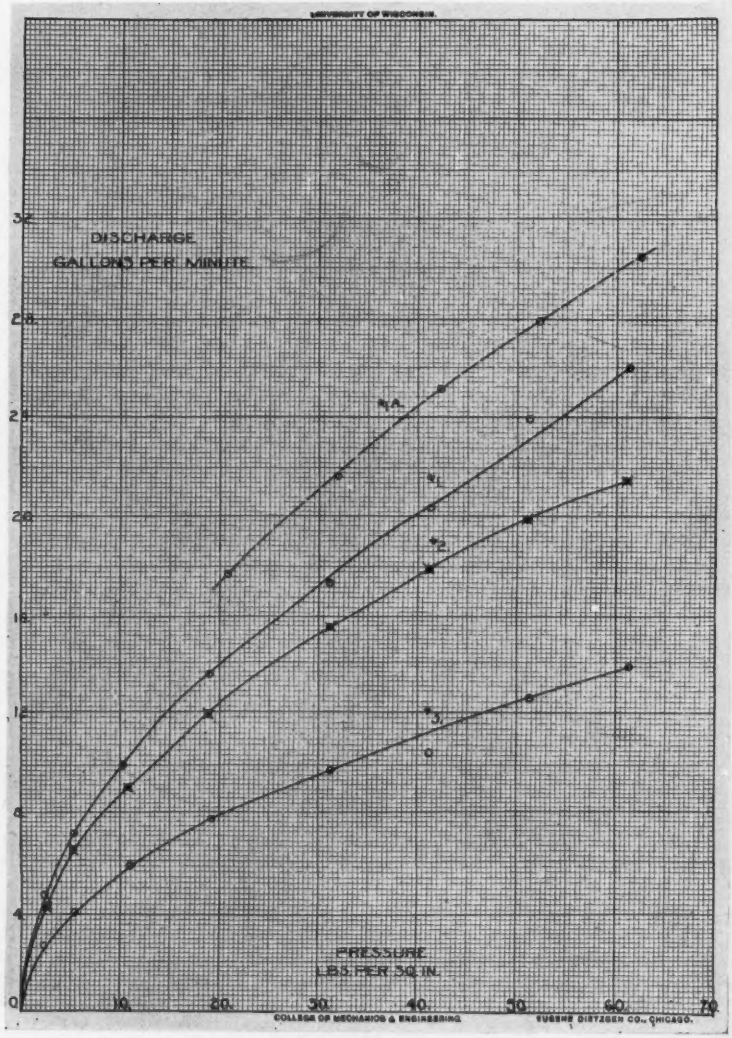
Referring to the diagram, curves No. 1, 2 and 3 give results obtained from the method shown in Figure No. 2 while curve No. 1A gives results of method shown in Figure No. 1. Curves No. 1 and No. 1A are for ⅜" orifices. Curve No. 2 for 5/16" orifice. Curve No. 3 for ¼" orifice.

Where figuring discharge of open sprinklers with pressure gauge attached to the top of a cross it is evident that curves No. 1, No. 2, and No. 3 will give approximate results except that the up stream sprinklers will probably discharge somewhat in excess of the figures noted in diagram, owing to the larger sized cross used especially with the ⅜" orifice. The variation in discharge according to the method of taking the pressure also is greater with the ⅜" orifice.

In estimating the discharge through a number of open sprinklers at any one level, as in a branch line, assuming that the average working pressure is known, curves No. 2 and No. 3 can be used and will undoubtedly give approximately correct results. For the ⅜" orifice, however, some figure between curves No. 1 and No. 1A will probably give more correct results than if No. 1 alone is used.



Method of Attaching Sprinklers and Pressure Gauge.



OPEN SPRINKLER DISCHARGE.

(Underwriters' Laboratories.)

No. 1 and No. 1A—⅛" Orifice.

No. 2—5-16" Orifice.

No. 3—¼" Orifice.